

# PATENT SPECIFICATION

DRAWINGS ATTACHED

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875,798

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International Classification:—C02c, C02d.

## COMPLETE SPECIFICATION

### Improvements in or relating to the Treatment of Sewage, or Industrial Waste Effluent

We, ACTIVATED SLUDGE LIMITED, a British Company of Abbey House, Victoria Street, Westminster, London S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is for improvements in or relating to the purification of sewage, or industrial waste effluent.

In the purification of sewage it has been the practice to pass the incoming screened and debris-free sewage through a preliminary sedimentation stage and it has also sometimes been the practice to treat the sewage in pre-aeration tanks before it passes into such preliminary sedimentation tanks. The main purpose of treating the sewage in pre-aeration tanks is:—

a. To freshen up the sewage if it is received at the sewage treatment plant in a stale or septic condition.

b. To obtain some flocculation of the sewage and thereby improve the efficiency of the treatment in the preliminary sedimentation tanks.

c. Effect removal of grease.

The first two objects set forth above can be achieved by providing the pre-aeration tanks with known forms of aeration, e.g. air jets or porous (e.g. stone) diffusers set in the bottom of the tank, air under pressure being introduced under the porous (e.g. stone) diffusers and diffusing up therethrough in the form of small bubbles. It is necessary with the diffuser arrangement that the diffusing air should cause sufficient agitation to prevent the solids in the sewage settling on the floor of the tanks. Unfortunately this agitation is objectionable from the point of view of obtaining removal of the grease because, although the grease particles may be caused to coagulate they are broken up again by such agitation.

An object of the present invention is therefore to provide improvements in the pre-aeration of the sewage or industrial waste effluent whereby although there is sufficient agitation to prevent settlement of solids on the floor of the tanks there is no interference with the coagulation and removal of the grease.

According to the present invention there is provided a process for the treatment of sewage or industrial waste effluent, which includes the steps of agitating the lower zone or region of the sewage or industrial waste effluent by jets of liquid, so as to prevent settlement of solids without seriously disturbing or agitating the main body of sewage or effluent and gently aerating the sewage or effluent so as to cause grease particles therein to coagulate.

Preferably this gentle aeration will be effected by introducing fine air bubbles into the sewage or effluent around which air bubbles the grease will collect and coagulate and rise to the surface as scum, so that it can be removed by known means.

Conveniently the process is carried out in apparatus comprising a pre-aeration tank including means for gently aerating the sewage so as to cause grease particles therein to coagulate and rise to the surface as scum, and liquid-jet producing means for agitating the sewage in the lower zone or region of the tank, so as to prevent settlement of solids, without seriously disturbing or agitating the sewage in other regions of the tank.

In one preferred method of carrying the invention into effect water jets are provided at floor level in the pre-aeration tank with means for introducing air to the inside of said jets so that water issuing from the jets keeps the solids in suspension, whilst at the same time the water jets disperse air as fine bubbles which gradually rise through the sewage in the tank and causes the required coagulation of the grease particles.

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One or more water jets may be provided for this purpose, the number used, their spacing and location being found by experiment so as to obtain the best results.

- 5 Alternatively one or more water jets may be provided for sweeping across the floor of the pre-aeration tank, so as to prevent any settling out of the solids before the sewage passes into the preliminary sedimentation tanks, separate air diffuser means being provided to give a gentle aeration which, although not sufficient in itself to give the required agitation of the sewage to prevent settlement, is sufficient to cause the grease particles to coagulate in the quiescent region of the tank and rise to the surface.

- 10 In, for example, a pre-aeration tank say 100 feet in length, a long row of water jets could be used to sweep the whole length of the tank, gentle air diffusion being introduced in, say, only the first 60 or 70 feet so that the latter part of the tank is quiescent at the surface.

- 15 The water jets above referred to may be located so as to discharge longitudinally and/or transversely of the tanks or some of them at least may be set at an angle so as to cause a slow spiral flow of the sewage. The arrangement will also be such that any parts of the floor of the tank not in the path of the jets will be kept clean by the currents induced by the water jets.

- 20 The process of the invention may be employed in any form of tank and gentle aeration may be applied over all or part of the tank. The tank employed may be of the type which has an aeration zone in the central part with slotted vertical baffles permitting flow from the top portion of the aerated zone to quiescent zones at the sides, the sides of the tank being vertical at their upper portion but sloping inwardly to the bottom of the tank at their lower portion.

- 25 Some particular embodiments of the invention will now be described by way of example with reference to the accompanying diagrammatic drawings. In these drawings:—

- 30 Figure 1 is a sectional view of a pre-aeration tank;

- 35 Figure 2 is a fragmentary plan view of the pre-aeration tank shown in Figure 1;

- 40 Figures 3 and 4 are plan views similar to Figure 2 but showing two alternative ways in which the means for effecting the pre-aeration can be arranged;

- 45 Figure 5 is a semi-diagrammatic sectional view of one form of combined air and water jet aerator particularly suitable for use in the pre-aeration tank;

- 50 Figure 6 is a sectional view of a further form of pre-aeration tank arrangement;

- 55 Figure 7 is a fragmentary plan view of the tank shown in Figure 6;

- 60 Figures 8 and 9 are plan views similar to Figure 7 but showing two alternative ways

in which the pre-aeration means may be arranged;

Figure 10 is a sectional view of a still further pre-aeration tank arrangement;

Figure 11 is a plan view of the tank shown in Figure 10;

Figure 12 is a sectional view through a still further form of pre-aeration tank;

70 Figures 13 and 14 are plan views and show two different arrangements of the pre-aeration means embodied in the tank shown in Figure 12;

Figure 15 is a cross-sectional view through a still further form of pre-aeration tank;

80 Figures 16 and 17 are plan views of the tank shown in Figure 15 and show two different arrangements of the pre-aeration means incorporated in this tank;

Figure 18 is a cross-sectional view through a still further form of pre-aeration tank;

85 Figure 19 is a plan view of the tank shown in Figure 18;

Figure 20 is a plan view similar to Figure 19 but showing an alternative arrangement of the pre-aeration means;

90 Figure 21 is a cross-sectional view through a still further form of pre-aeration tank;

Figure 22 is a plan view of the pre-treatment tank shown in Figure 21;

95 Figure 23 is a cross-sectional view through a still further form of pre-aeration tank;

Figures 24 and 25 are plan views of the pre-aeration tank shown in Figure 23 and illustrate two alternative arrangements of the pre-aeration means;

100 Figure 26 is a semi-diagrammatic detail view of an impingement form of aerator adapted to constitute the pre-aeration means; and

105 Figure 27 is a semi-diagrammatic detail view of a Venturi form of aerator.

Throughout the drawings the reference numeral 10 indicates the pre-treatment tank, the long arrows indicate the direction of flow of the water and the short arrows the direction of flow of the air.

110 In the embodiment of the invention shown in Figure 1 the pre-treatment is carried out by combined air and water jets 11 which are mounted on and project laterally from, a water main 12, air being supplied to the jets from an air main 13 via a branch pipe 14.

One of the combined air and water jet aerators is shown in detail in Figure 5. Referring to Figure 5, the reference numeral 15 indicates the water jet and it will be

120 noted that this is screwed into the water main 12 and projects into but terminates short of the end of the air jet 16. The latter has a branch 17 for connection to the air supply branch 14. The air and water issue at high speed from the jet-end 18 of the aerator, the water sweeping across the bottom or lower part of the tank so as to prevent settlement of the solids whilst the air rises gently so as to cause coagulation of the grease particles.

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Three typical alternative arrangements for the combined air and water jet aerators 11 are shown in Figures 2, 3 and 4. In the arrangement shown in Figure 2 the aerators are arranged so that the water jets sweep transversely across the floor or lower part of the pre-treatment tank, in the arrangement shown in Figure 3 the water jets sweep diagonally across the floor or lower part of the tank, and in the arrangement shown in Figure 4 they operate in the longitudinal direction of the tank so as to effect a longitudinal sweeping action.

In the arrangement shown in Figure 6 the combined air and water jet aerators 11 are arranged towards one side of the tank so that the water sweeps across from one side to the other as shown in Figure 7.

As an alternative to the arrangement shown in Figure 7, the aerators 11, located at one side of the tank as shown in Figure 6, may be set as shown in Figure 8 so as to operate diagonally across the tank or as shown in Figure 9 so as to operate longitudinally of the tank.

In the embodiment of the invention shown in Figure 10 the water main is arranged transversely instead of longitudinally of the tank and the aerators 11 are set so that they sweep the tank longitudinally as shown in Figure 11.

In the arrangement shown in Figure 12 the pre-aeration tank has centrally located oppositely directed aerators 11 set in a ridge 10a on the base of the tank and the tank is divided by partitions 19 into an aeration zone 20 and quiescent zones 21. The aerators in this arrangement may, for example, be arranged to sweep transversely across the bottom of the tank as shown in Figure 13 or diagonally as shown in Figure 14.

Figure 15 shows an arrangement similar to that just described with reference to Figure 12 except that rows of single aerators 11 are set one to one side and one to the other side of the tank which may have a central ridge 10a. Here again the aerators may be arranged to sweep transversely across the tank as shown in Figure 16 or they may be arranged to operate diagonally as shown in Figure 17.

In the arrangement shown in Figure 18 the air diffusers and the water jets are separate elements. In this figure, 22 indicates the aerators which diffuse air in the form of small bubbles, whilst 23 indicates the water jets which are mounted on the water main 12. There may, for example, be five rows of air diffusers as shown in Figure 19 and two or more transverse rows of water jets, or alternatively three rows of diffusers and one or more rows of water jets as shown in Figure 20. Various alternative arrangements or combinations of separate diffusers and water jets

are of course possible and will be adapted to suit particular circumstances.

Figures 21 and 22 show an arrangement similar to that just described with reference to Figures 18, 19 and 20 except that the tank is provided with partitions 19 to divide it into an aeration zone 20 and two quiescent zones 21.

Figures 23, 24 and 25 show arrangements similar to that described with reference to Figures 21 and 22 except that instead of operating longitudinally of the tank the water jets operate transversely across the tank from the sides thereof as shown in Figure 24 or diagonally as shown in Figure 25.

The impingement form of combined water jet or "sweep" and aerator shown in Figure 26 comprises a water jet 25 of which there may be a series mounted along the water main 122, and a deflector, of saucer shape, 26, of which there may be several mounted along the air main 27 in vertical alignment with the several water nozzles 25. The mains 12 and 27 will, of course, be located close to the floor of the pre-aeration tank. The air is discharged into the deflector 26 via lateral openings 28 and the water jet impinges on the dome-shaped centre 29 of the deflector. The result is that the water is directed laterally in all directions so as to sweep the bottom or lower part of the tank whilst the air is broken up into small bubbles which rise to the upper part of the tank and cause the desired coagulation of the grease.

In the Venturi form of aerator shown in Figure 27 the Venturi tube 30 forms an extension of a water supply branch 31 and the air supply pipe 32 is connected to the throat of the Venturi tube. There will of course be several such aerators spaced along and/or across the pre-aeration tank. The water and air meeting in the throat of the Venturi tube leave the aerator in such a way that the water sweeps at high velocity across the lower part or bottom of the tank whilst the air which has been broken up into small bubbles rises. It will be noted that the entrance for the air into the Venturi throat is in the form of fine slots or orifices 33 and the velocity of the water sluices off air bubbles from these fine slots or orifices.

Water for the water jets may be drawn from the final effluent from the plant.

In any of the arrangements above described, where there are water jets with separate air diffusers, air jets may replace these air diffusers. A mechanically driven rotor or the like may be provided in a separate tank and this is designed and situated so as to churn up water and air into bubbles, which churned up water and air is then piped to discharge jets suitably disposed in the pre-aeration tank.

A gas other than air may be diffused or discharged into the liquid in the tank to be



treated. For example, CO<sub>2</sub> may be used in some of the arrangements above described.

**WHAT WE CLAIM IS:—**

1. A process for the treatment of sewage or industrial waste effluent, which includes the steps of agitating the lower zone or region of the sewage or industrial waste effluent by jets of liquid, so as to prevent settlement of solids without seriously disturbing or agitating the main body of sewage or effluent and gently aerating the sewage or effluent so as to cause grease particles therein to coagulate.

2. A process as claimed in Claim 1 wherein the gentle aeration is effected by introducing fine air bubbles into the sewage or industrial waste effluent around which air bubbles grease particles collect and coagulate and rise to the surface as scum.

3. A process as claimed in Claim 1 or 2 in which apparatus is used comprising a pre-aeration tank including means for gently aerating the sewage so as to cause grease particles therein to coagulate and rise to the surface as scum, and liquid-jet producing means for agitating the sewage in the lower zone or region of the tank, so as to prevent settlement of solids, without seriously disturbing or agitating the sewage in other regions of the tank.

4. A process as claimed in Claim 3 wherein water jets are provided at or near floor level in the tank, means also being provided for introducing air to the inside of said jets so that water issuing from the jet keeps the solids in suspension whilst at the same time the water jets disperse air as fine bubbles which gradually rise through the sewage or

effluent in the tank and causes coagulation of grease particles.

5. A process as claimed in Claim 3 or 4 wherein one or more water jets is or are provided for sweeping across the floor of the tank so as to prevent settlement of the solids before the sewage or effluent passes into a preliminary sedimentation tank, separate air diffuser means being provided in the aerating zone to give a gentle aeration which, although not sufficient in itself to give the required agitation of the sewage to prevent settlement, is sufficient to cause grease particles to coagulate in the quiescent region of the tank and rise to the surface.

6. A process as claimed in any of the preceding Claims 3 to 5 and wherein the tank has partitions to divide it into an aeration zone and quiescent zones.

7. A process for the treatment of sewage or industrial waste effluent substantially as herein described with reference to the accompanying drawings.

8. A process as claimed in any of the preceding claims and carried out in a plant substantially as herein described with reference to Figures 1 and 2, 3 or 4; Figures 6 and 7, 8 or 9; Figures 10 and 11; Figures 12 and 13 or 14; Figures 15 and 16 or 17; Figures 18 and 19 or 20; Figures 21 and 22, or Figures 23 and 24 or 25 of the accompanying drawings.

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**PROVISIONAL SPECIFICATION**

**Improvements in or relating to the Treatment of Sewage, Industrial Waste and the Like**

We, ACTIVATED SLUDGE LIMITED, a British Company of Abbey House, Victoria Street, Westminster, London S.W.1, do hereby declare this invention to be described in the following statement:—

This invention is for improvements in or relating to the purification of sewage, industrial waste and the like.

In the purification of sewage it has been the practice to pass the incoming screened and detritus-free sewage through a preliminary sedimentation stage and it has also sometimes been the practice to treat the sewage in pre-aeration tanks before it passes into such preliminary sedimentation tanks. The main purpose of treating the sewage in pre-aeration tanks is:—

- a. To freshen up the sewage if it is received at the sewage treatment plant in a stale or septic condition.
- b. To obtain some flocculation of the sewage and thereby improve the efficiency of the

treatment in the preliminary sedimentation tanks.

*c. Effect removal of grease.*

The first two objects set forth above can be achieved by providing the pre-aeration tanks with known forms of aeration, e.g. air jets or porous stone diffusers set in the bottom of the tank, air under pressure being introduced under the porous stone diffusers and diffusing up therethrough in the form of small bubbles. It is necessary with the diffuser arrangement that the diffusing air should cause sufficient agitation to prevent the solids in the sewage settling on the floor of the tanks. Unfortunately this agitation is objectionable from the point of view of obtaining removal of the grease because, although the grease particles may be caused to coagulate they are broken up again by such agitation.

An object of the present invention is therefore to provide improvements in the pre-aeration of the sewage and the like whereby

although there is sufficient agitation to prevent settlement of solids on the floor of the tanks there is no interference with coagulation and removal of the grease and the like.

5 According to the present invention there is provided a process for the treatment of sewage and other trade waste or the like, which includes the steps of agitating the lower zone or region of the sewage, at least periodically, 10 so as to prevent settlement of solids without seriously disturbing or agitating the main body of liquid, and gently aerating the liquid so as to cause grease particles or the like therein to coagulate.

15 Preferably this gentle aeration will be effected by introducing fine air bubbles into the sewage or the like around which air bubbles the grease will collect and coagulate and rise to the surface as scum, so that it can be 20 removed by known means.

According to a further feature of the present invention there is provided in or for use in a plant for the treatment of sewage, industrial waste and the like, a pre-aeration tank 25 including means for gently aerating the sewage so as to cause grease particles therein to coagulate and rise to the surface as scum, and means for agitating the sewage in the region of such aerating means so as to prevent settle- 30 ment of solids without seriously disturbing or agitating the sewage in other regions of the tank.

In one preferred method of carrying the invention into effect water jets are provided 35 at floor level in the pre-aeration tank or tanks with means for introducing air to the inside of said jets so that water issuing from the jets keeps the solids in suspension, whilst at the same time the water jets disperse air as 40 fine bubbles which gradually rise through the sewage in the tank and causes the required coagulation of the grease particles and the like.

One or more water jets may be provided 45 for this purpose, the number used, their spacing and location being found by experiment so as to obtain the best results.

Alternatively one or more water jets may be provided for sweeping across the floor or 50 other aerating region of the pre-aeration tank, so as to prevent any settling out of the solids before the sewage passes into the preliminary sedimentation tanks, separate air diffuser means being provided in said aerating region

to give a gentle aeration which, although not 55 sufficient in itself to give the required agitation of the sewage to prevent settlement, is sufficient to cause the grease particles to coagulate in the quiescent region of the tank and rise to the surface. 60

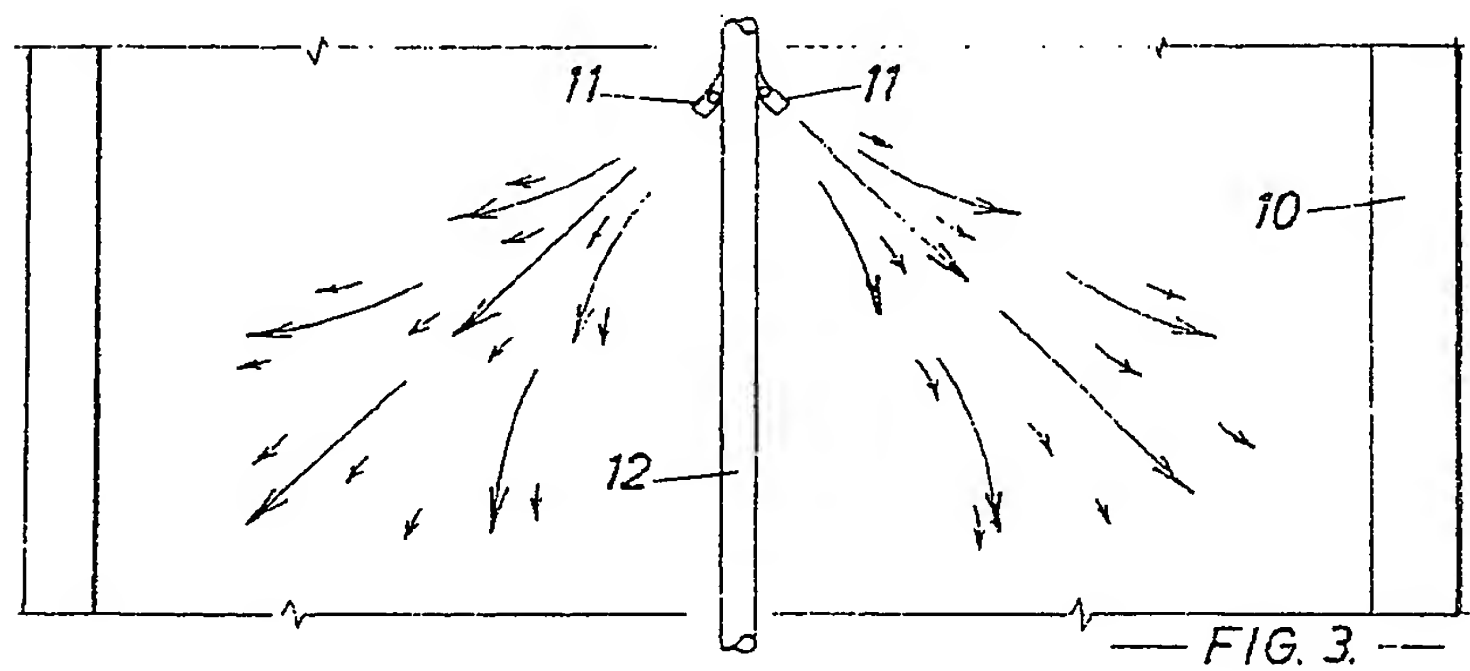
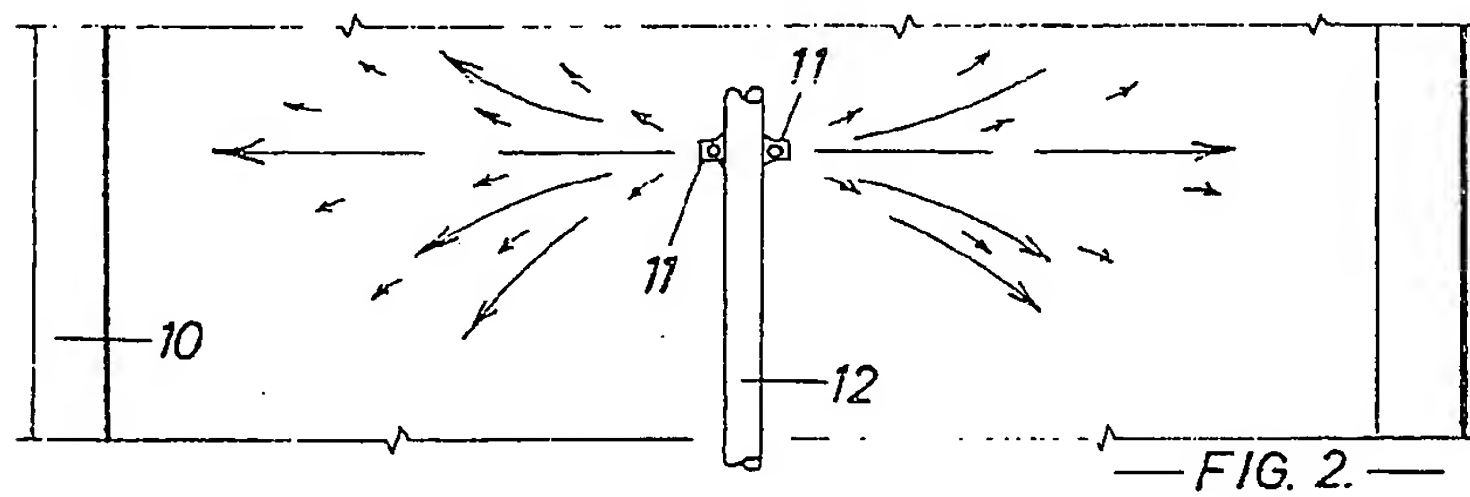
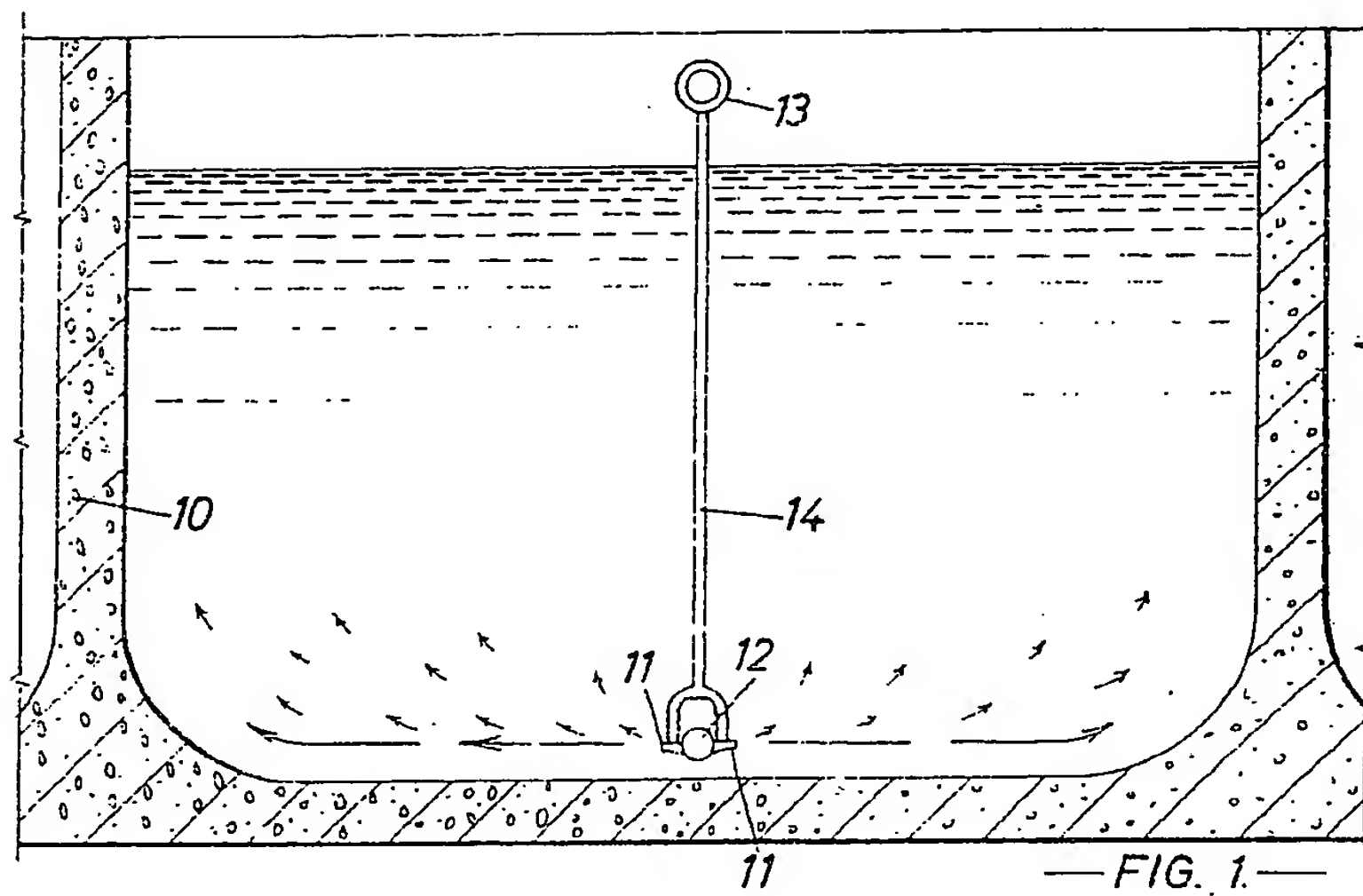
In, for example, a pre-aeration tank say 100 feet in length long water jets could be used to sweep the whole length of the tank, gentle air diffusion being introduced in, say, 65 only the first 60 or 70 feet so that the latter part of the tank is quiescent at the surface. On the other hand, the pre-aeration tank may be constructed so that there are alternate sections or regions of aeration and quiescence at the upper zone of the liquid, the whole bottom 70 of the tank being swept clear by water jets so as to prevent any settling out of the solids.

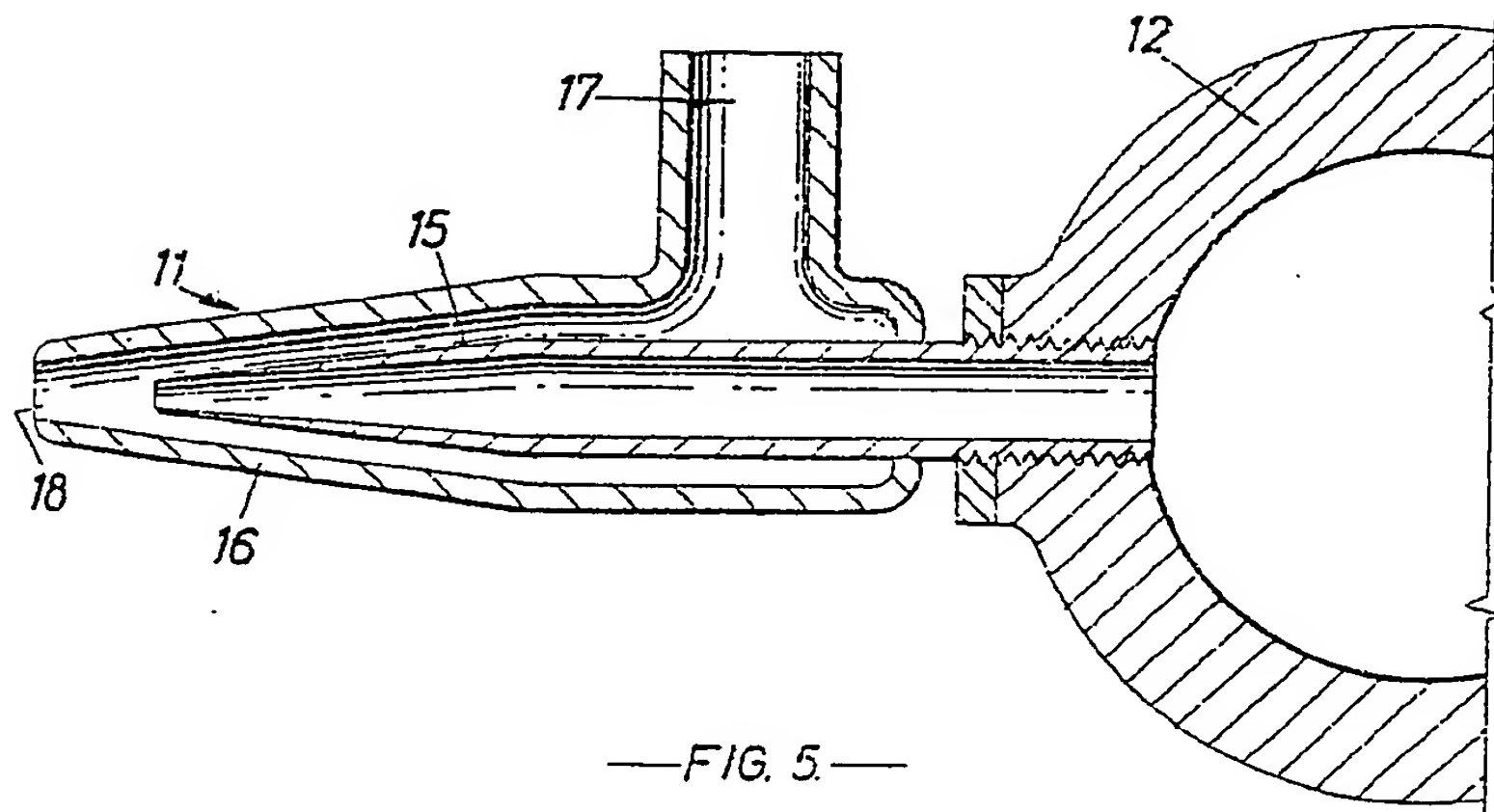
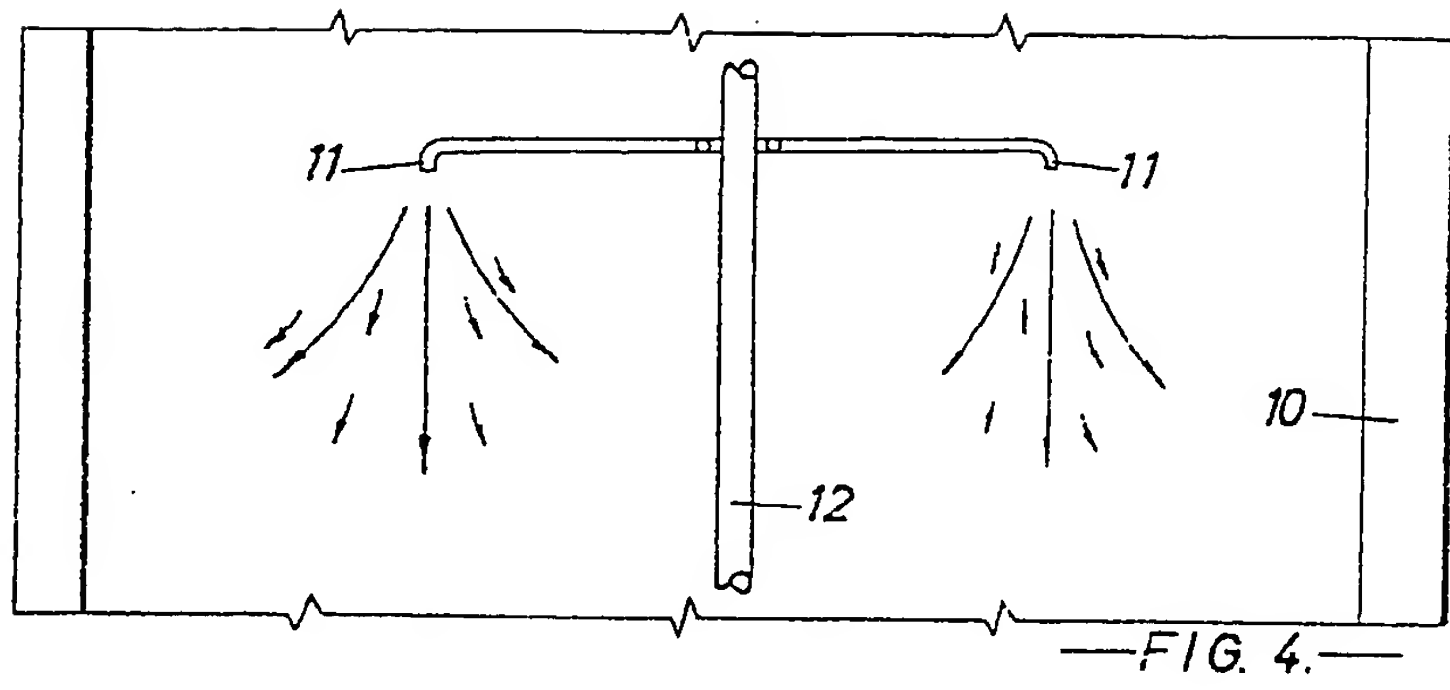
The water jets above referred to may be located so as to discharge longitudinally and/or 75 transversely of the tanks or some of them at least may be set at an angle so as to cause a slow spiral flow of the sewage. The arrangement will also be such that any parts of the floor of the tank not in the path of the jets will be kept clean by the currents induced by 80 the water jets.

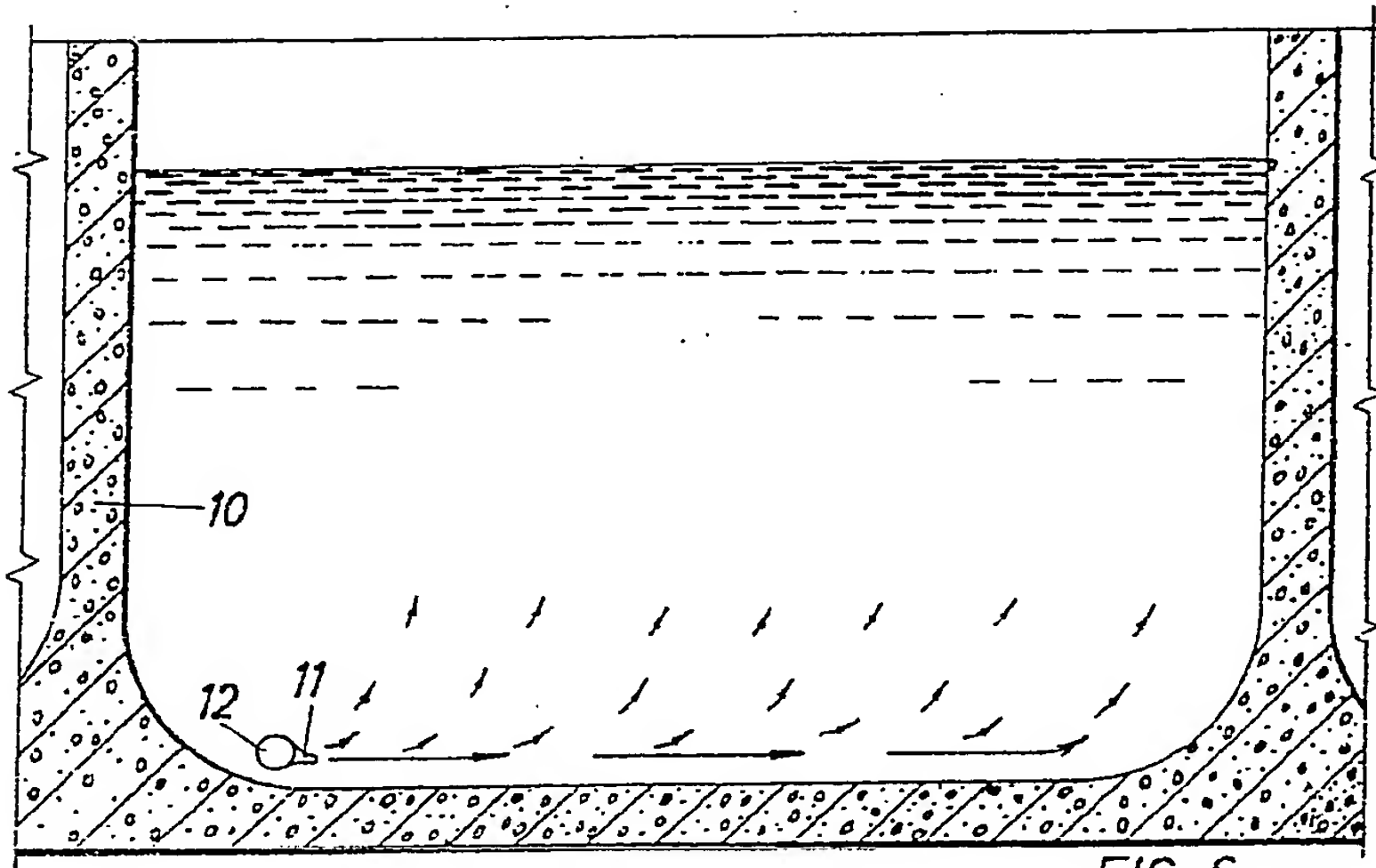
The process of the invention may be employed in any form of tank and gentle aeration may be applied over all or part of the tank. Thus, in addition to the example previously 85 mentioned the tank employed may be of a well known type which has an aeration zone in the central part with slotted baffles permitting flow from the top portion of the aerated zone to quiescent zones at the sides, 90 the sides of the tank being vertical at their upper portion but sloping inwardly to the bottom of the tank at their lower portion.

It will be appreciated that from one point of view a basic feature of the invention is the 95 provision of water jets or other means to prevent settlement of the solids in the pre-aeration tanks whilst at the same time gently aerating the liquid in the tanks either through the water jets or by other means so as to 100 obtain coagulation in a quiescent zone of the grease so that it will rise to the surface and can be removed before the sewage passes onto the preliminary sedimentation tanks.

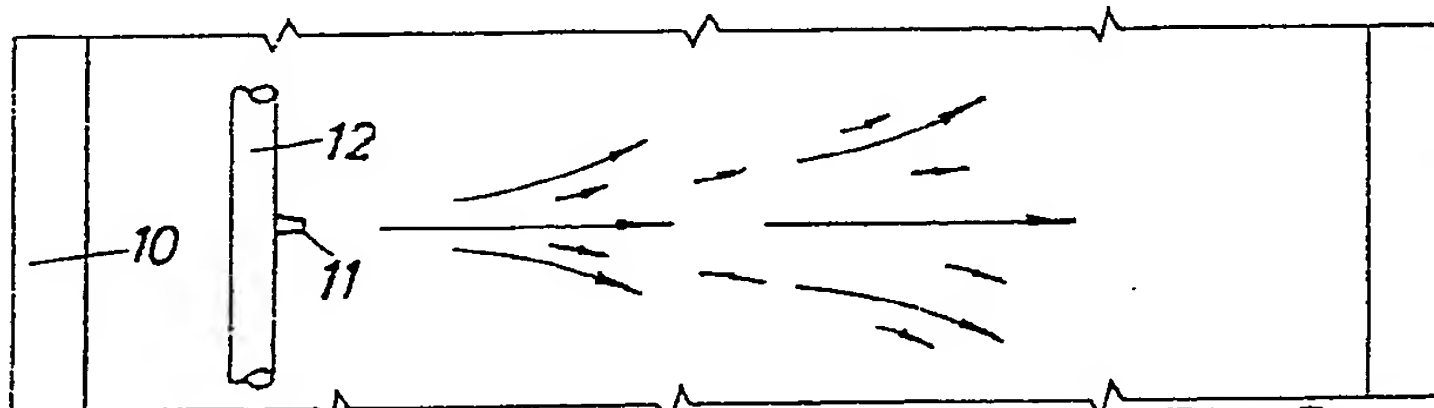
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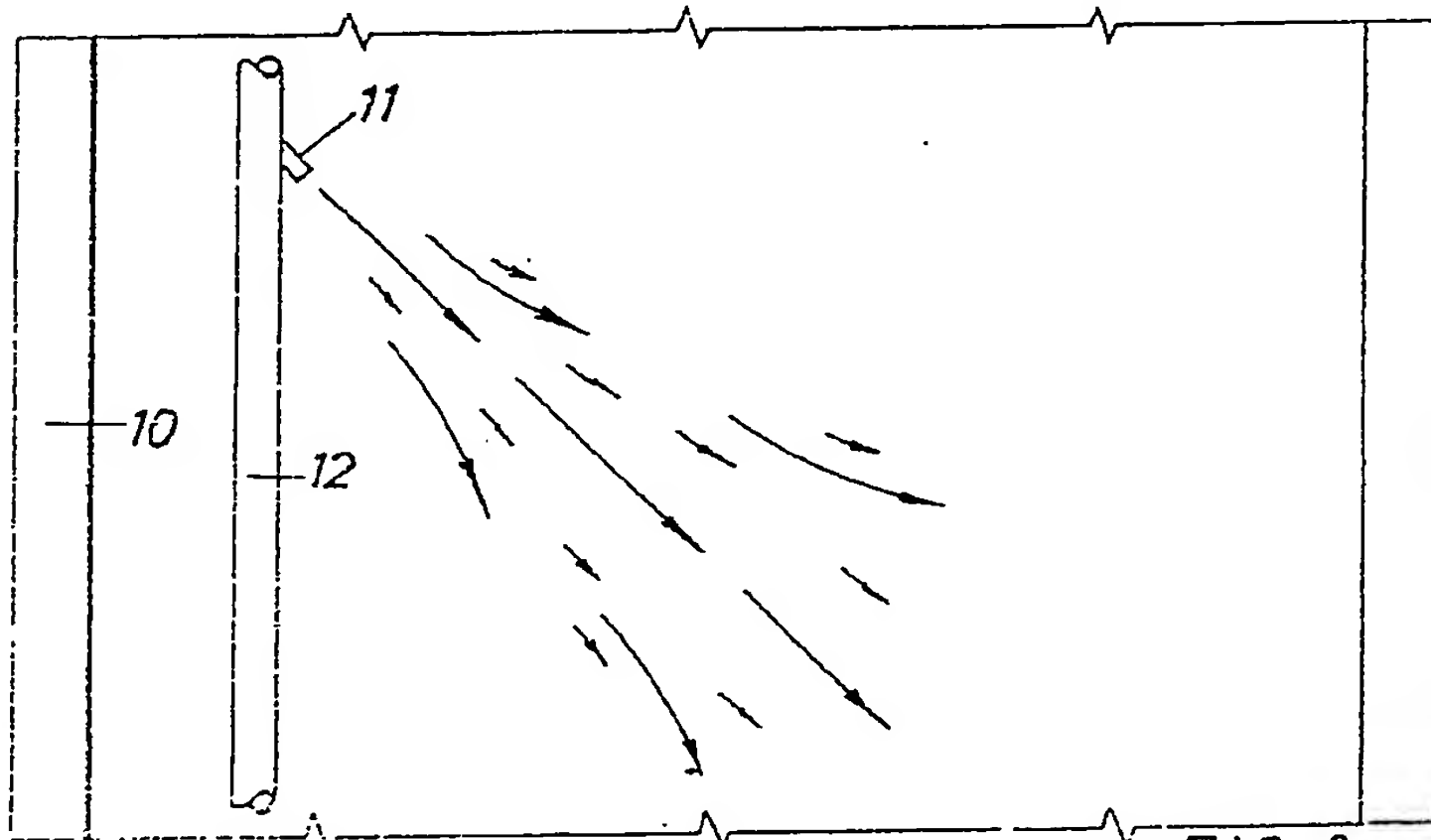




— FIG. 6. —

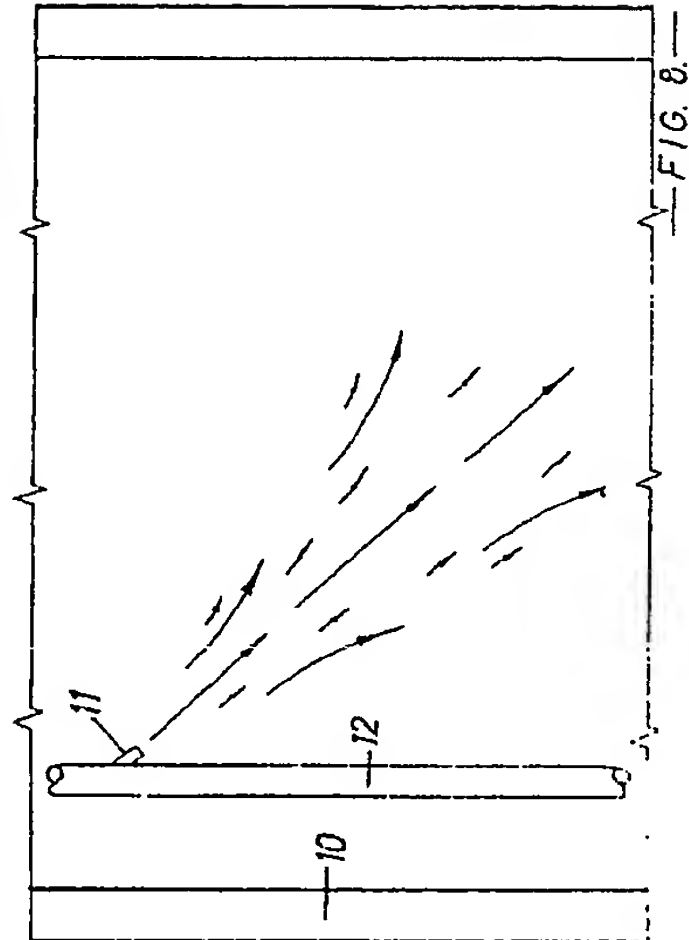
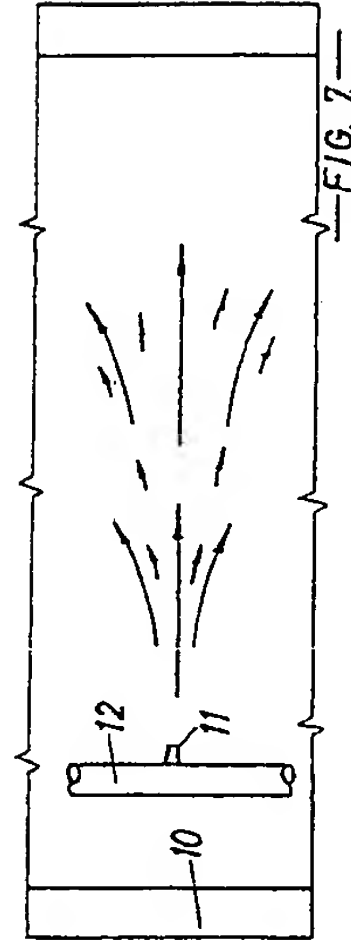
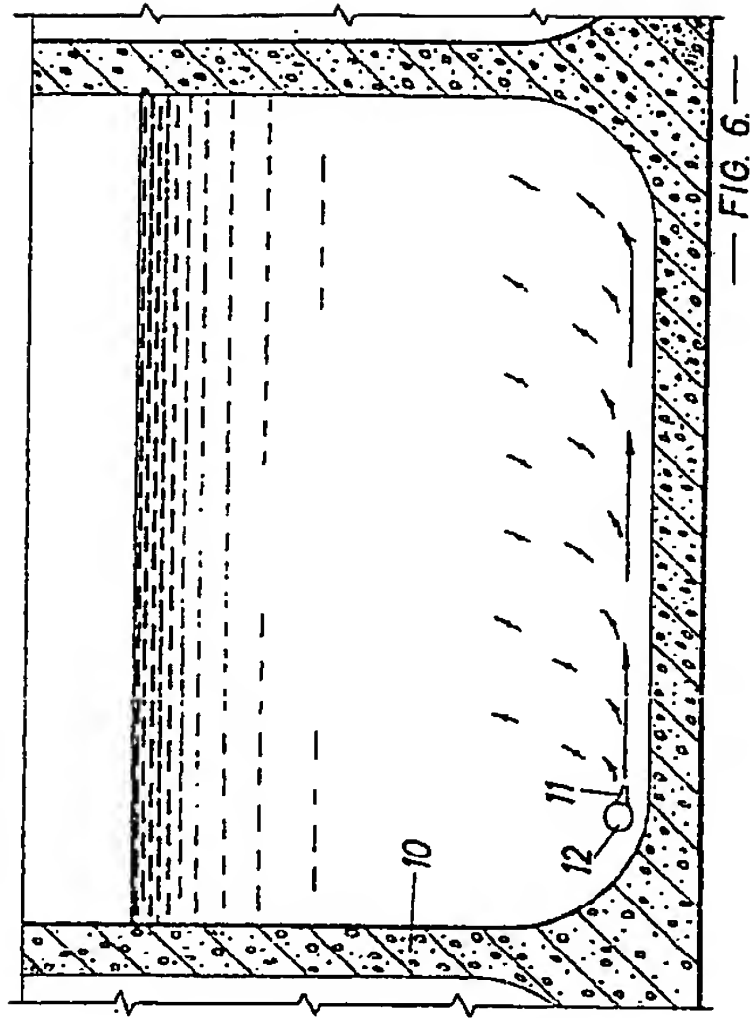
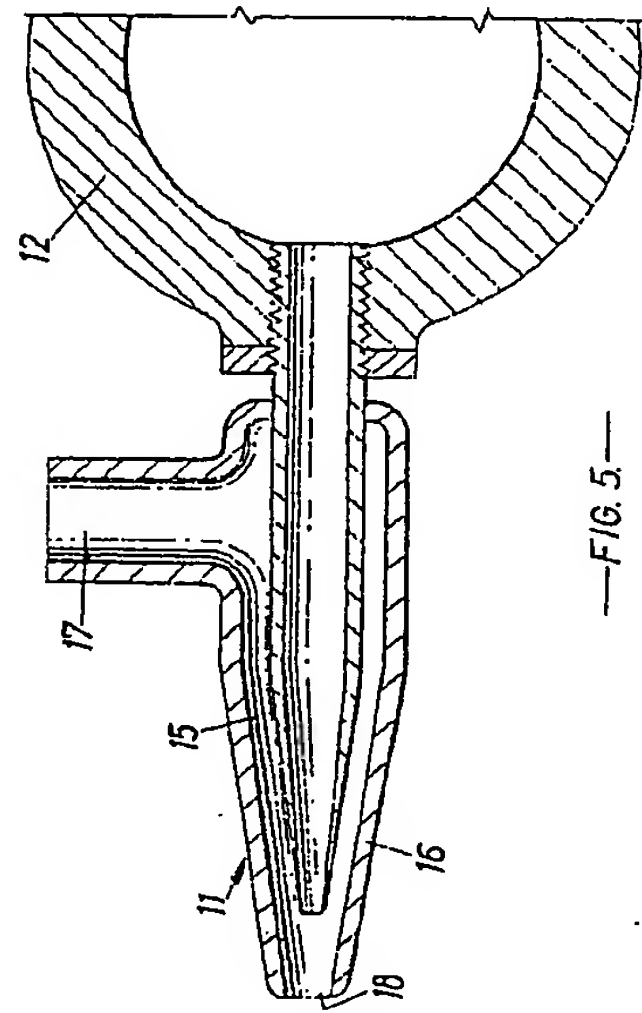
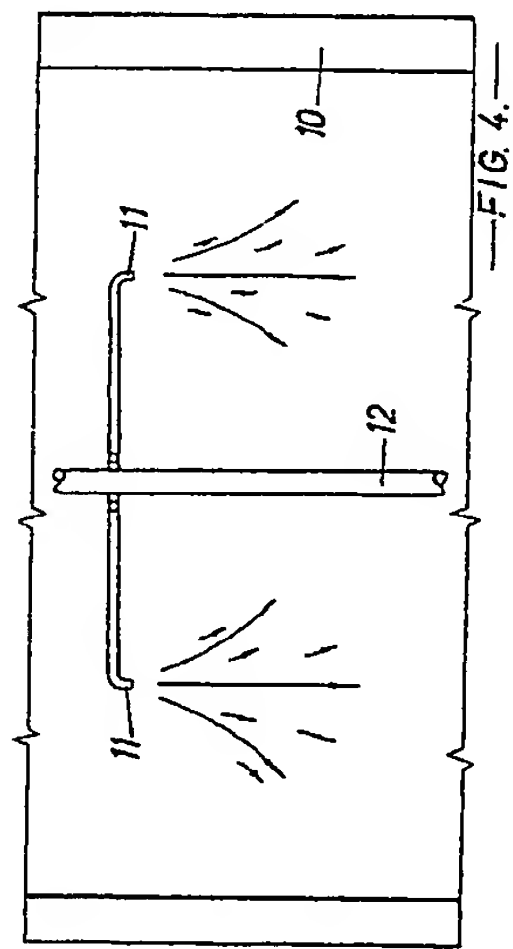


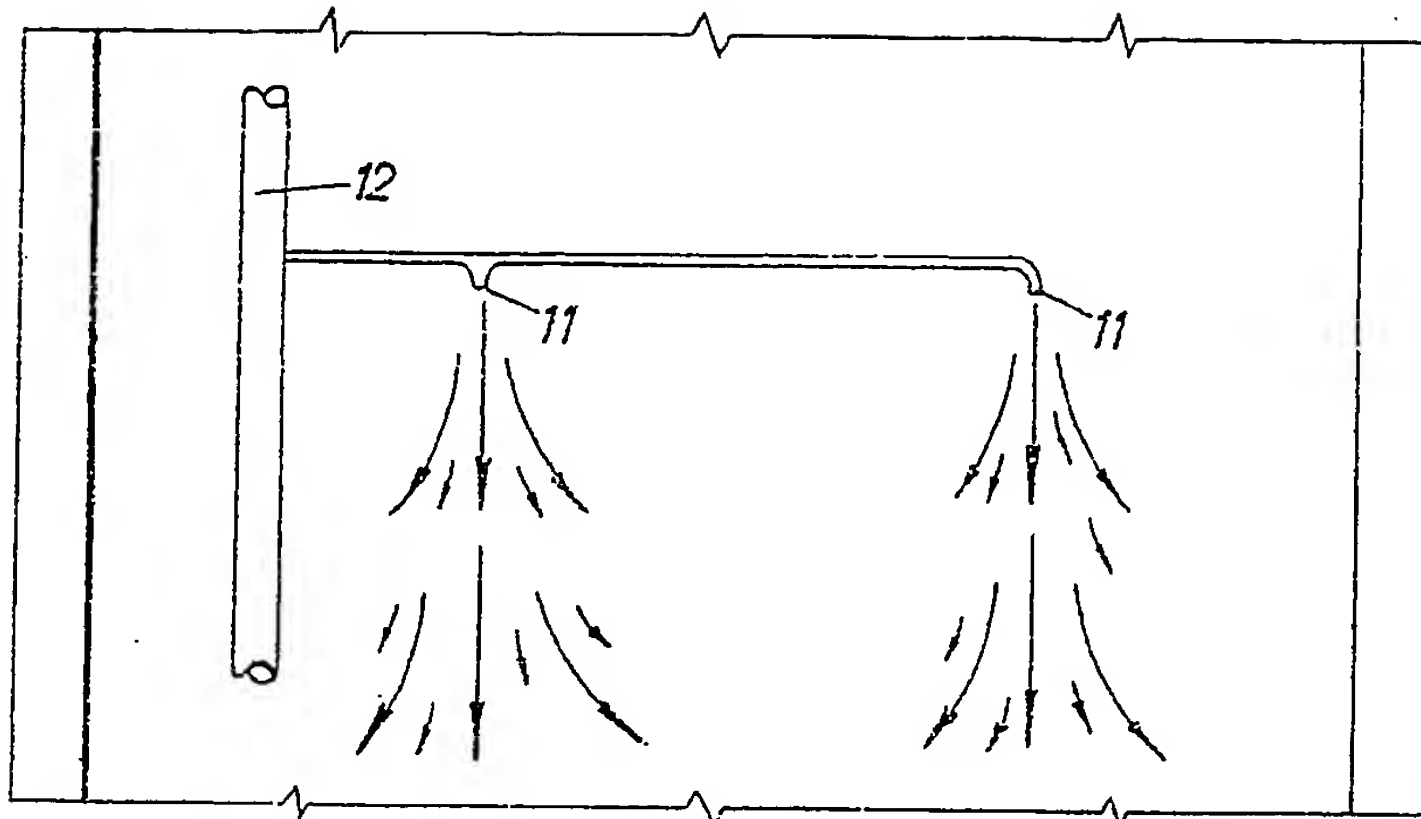
— FIG. 7. —



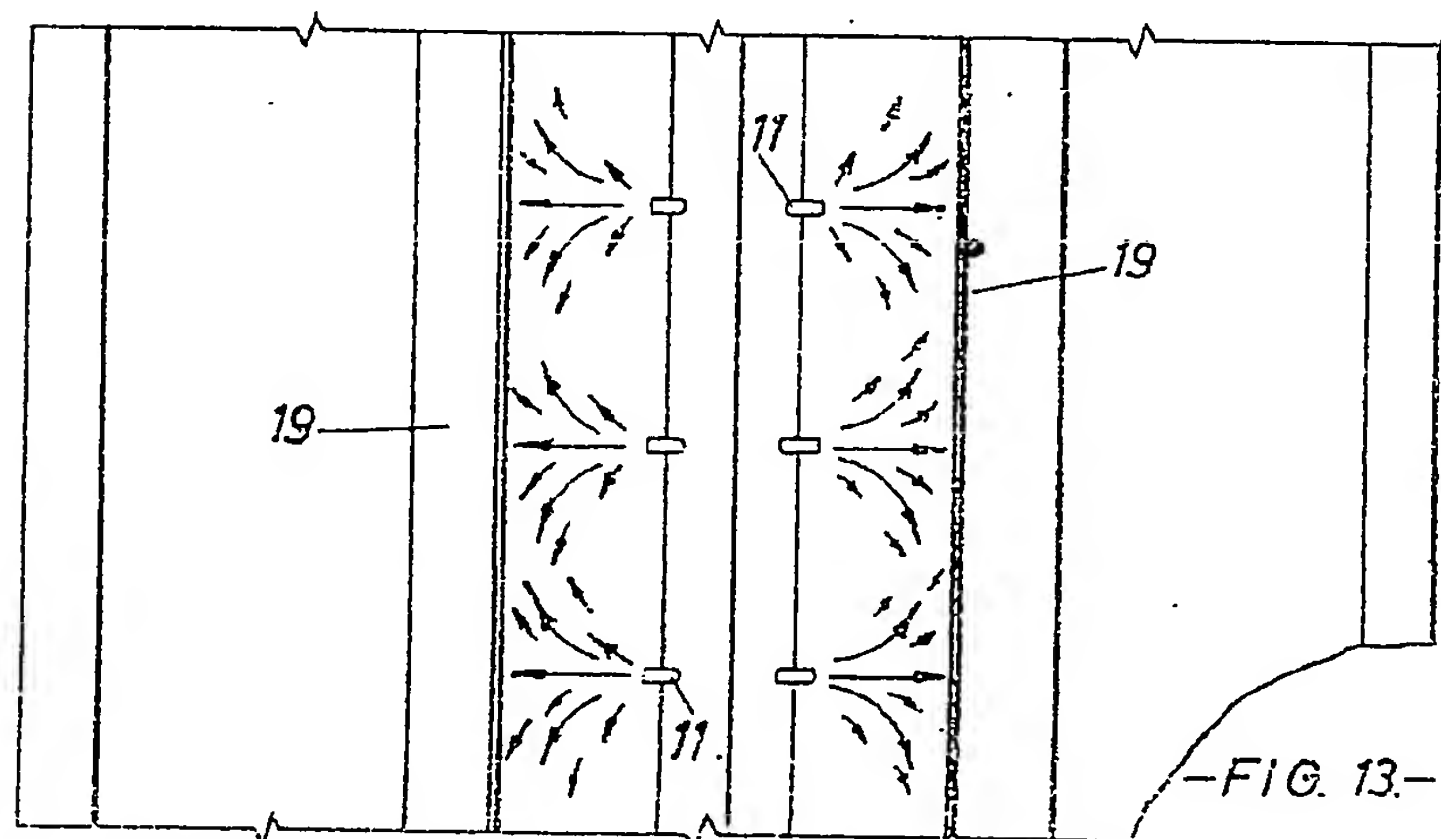
— FIG. 8. —



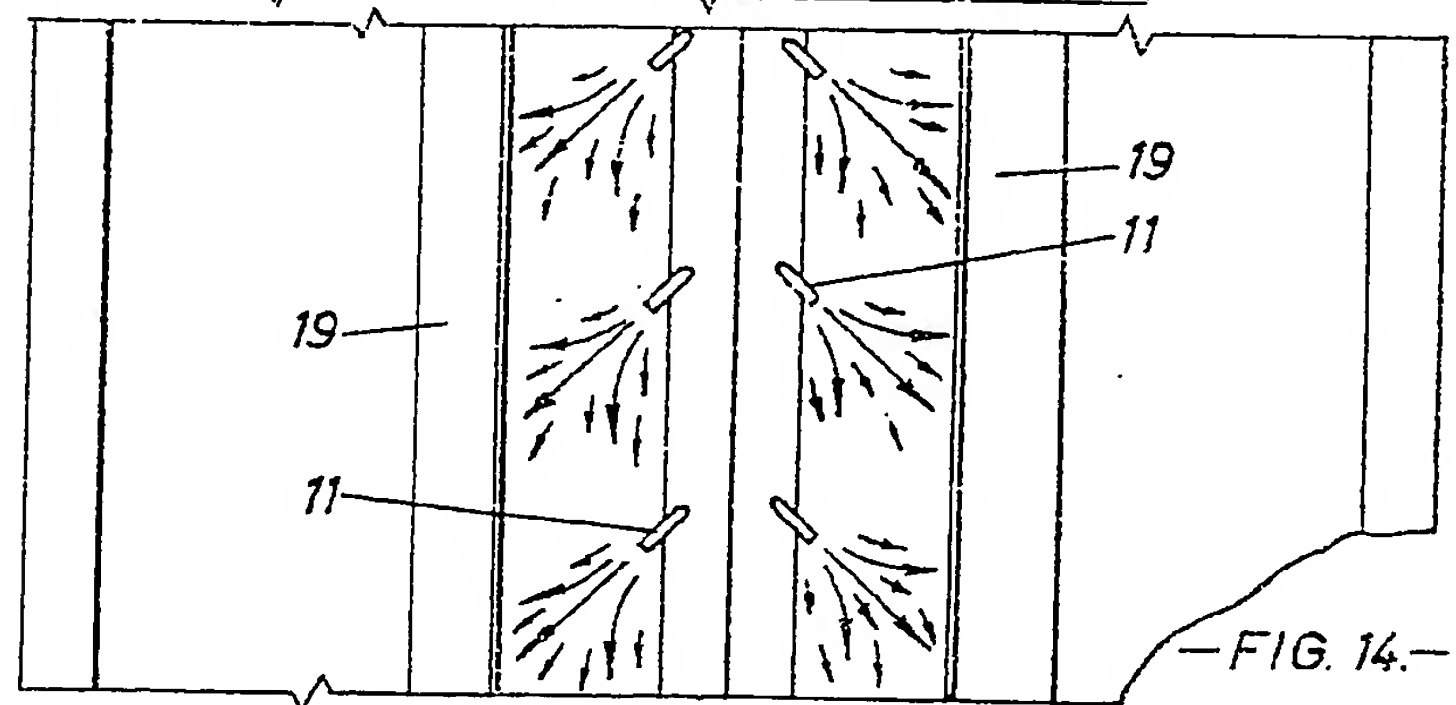




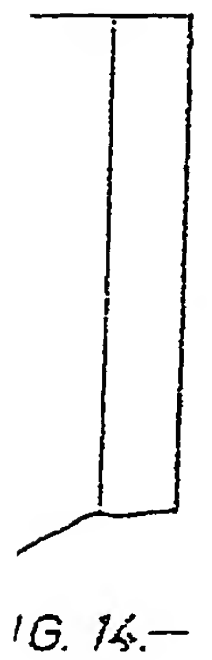
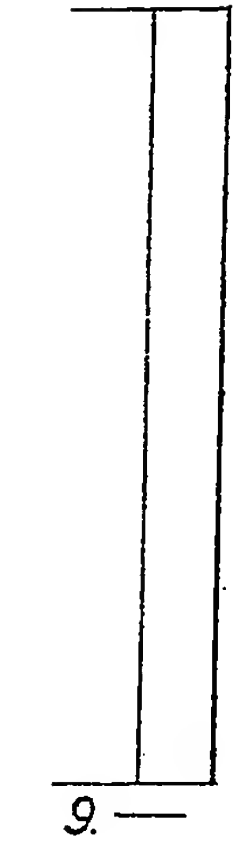
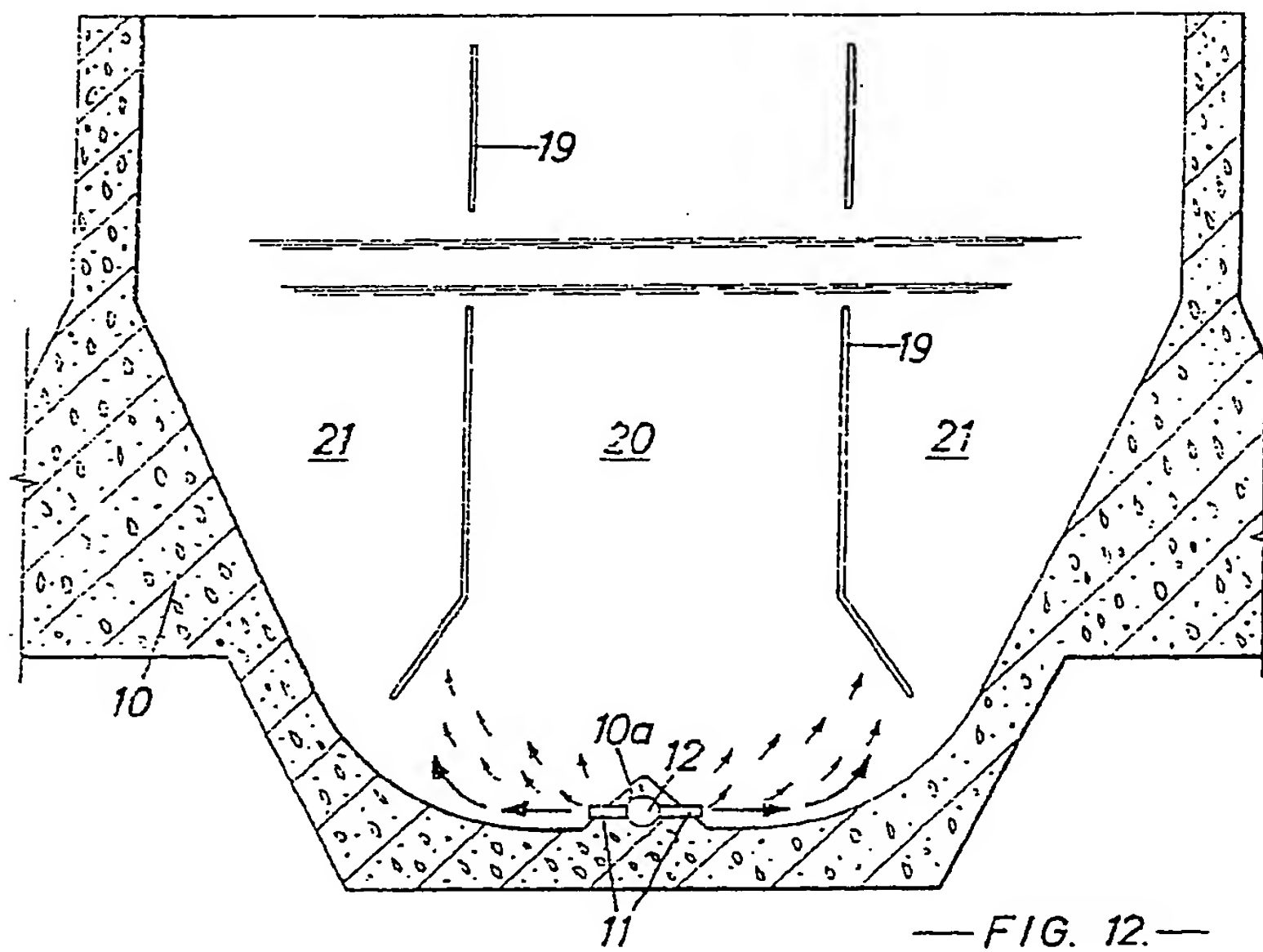
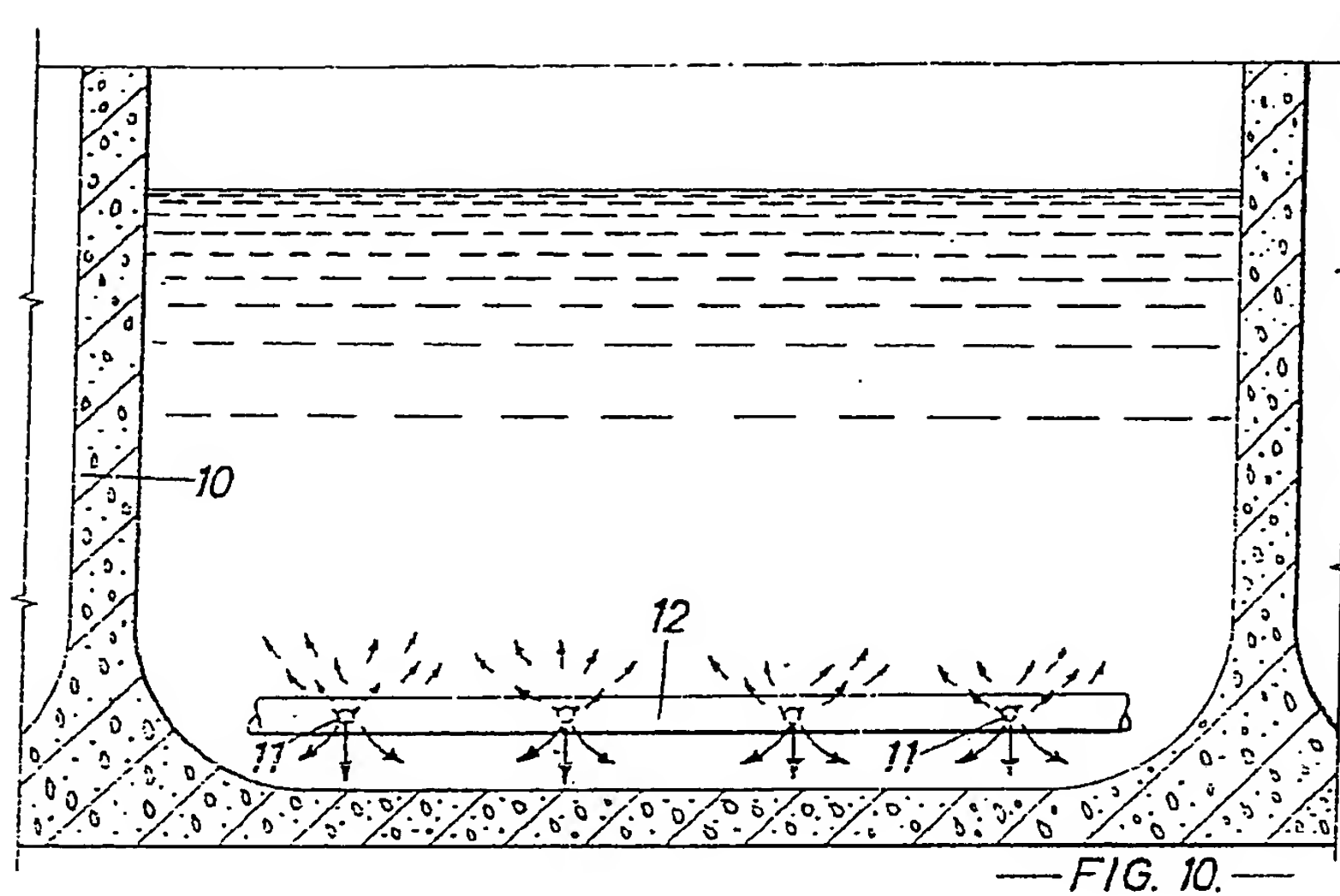
—FIG. 9.—

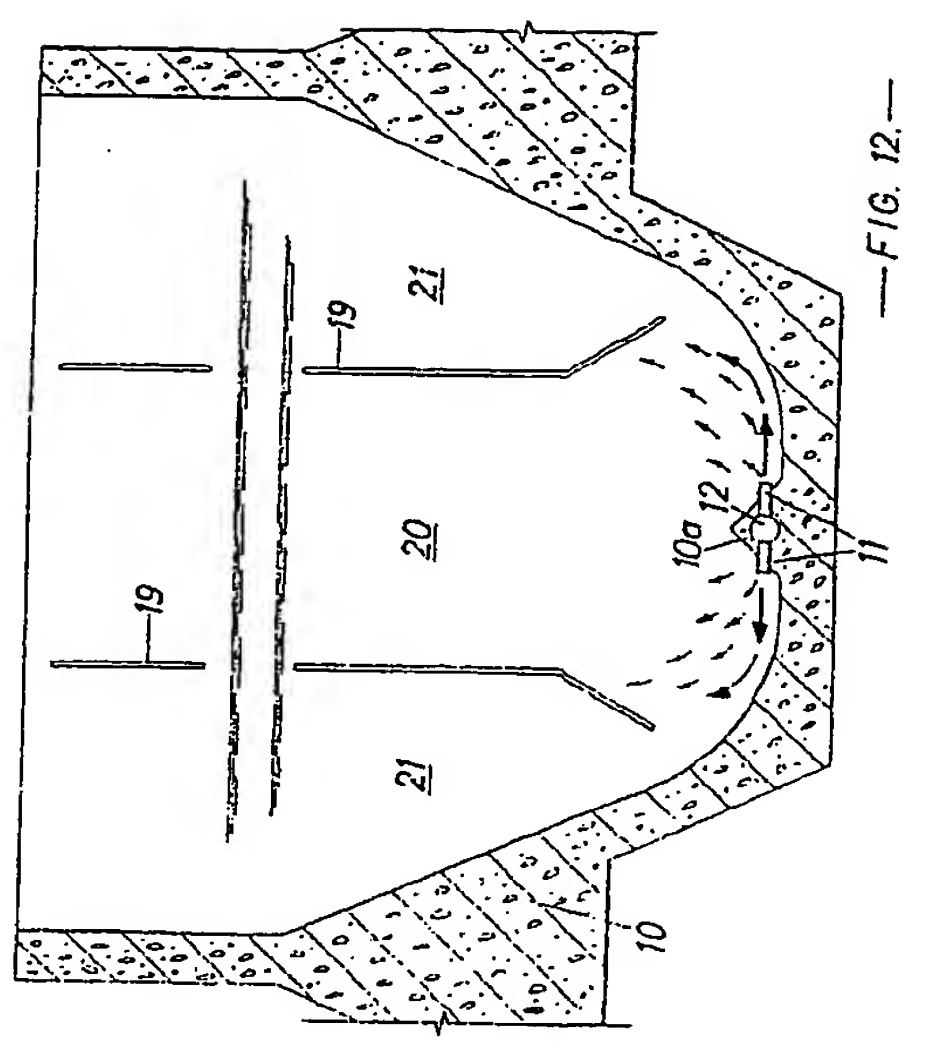
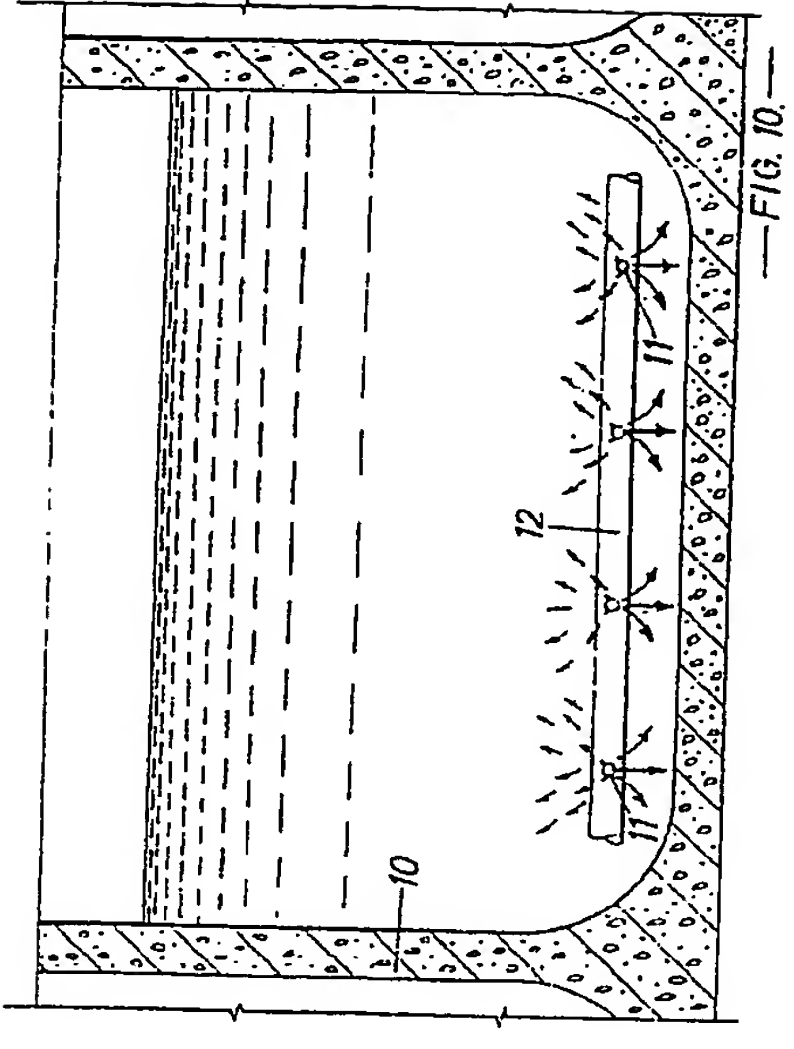
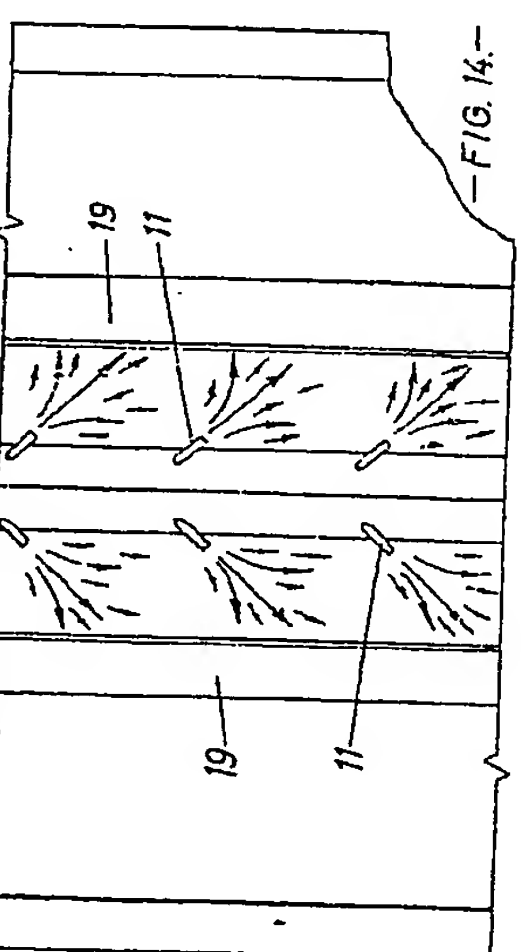
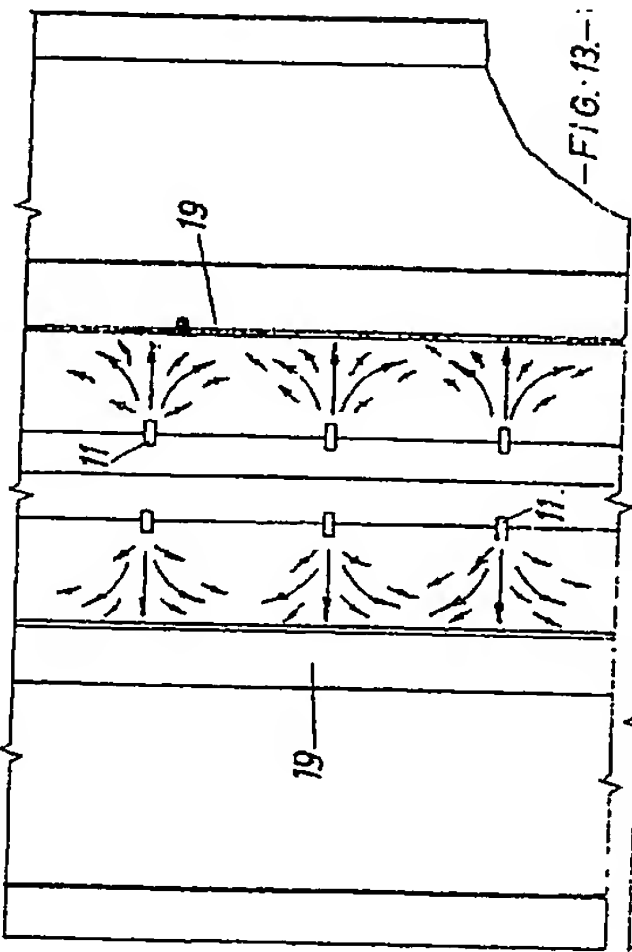
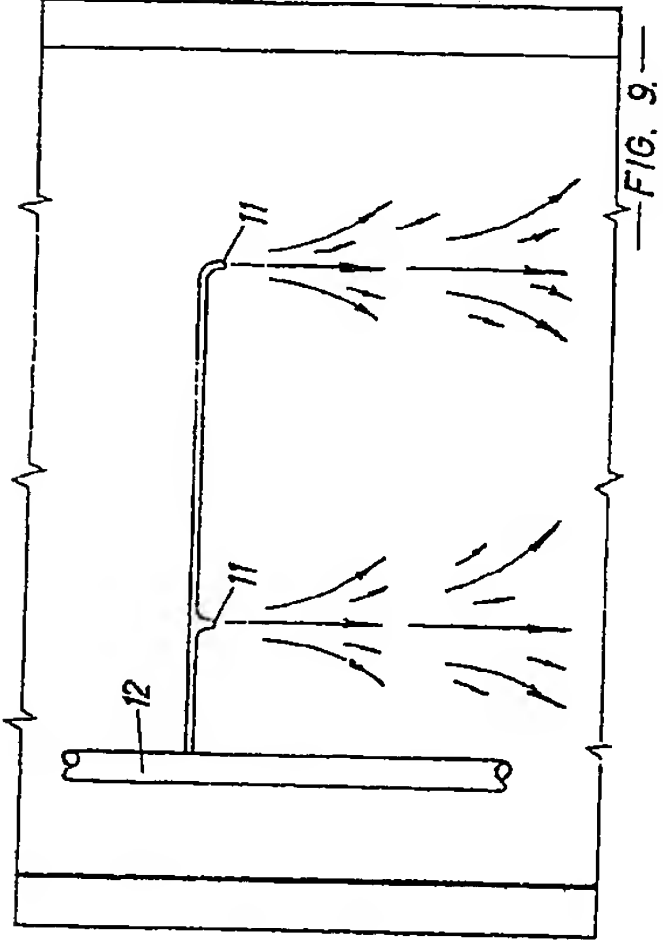


—FIG. 13.—

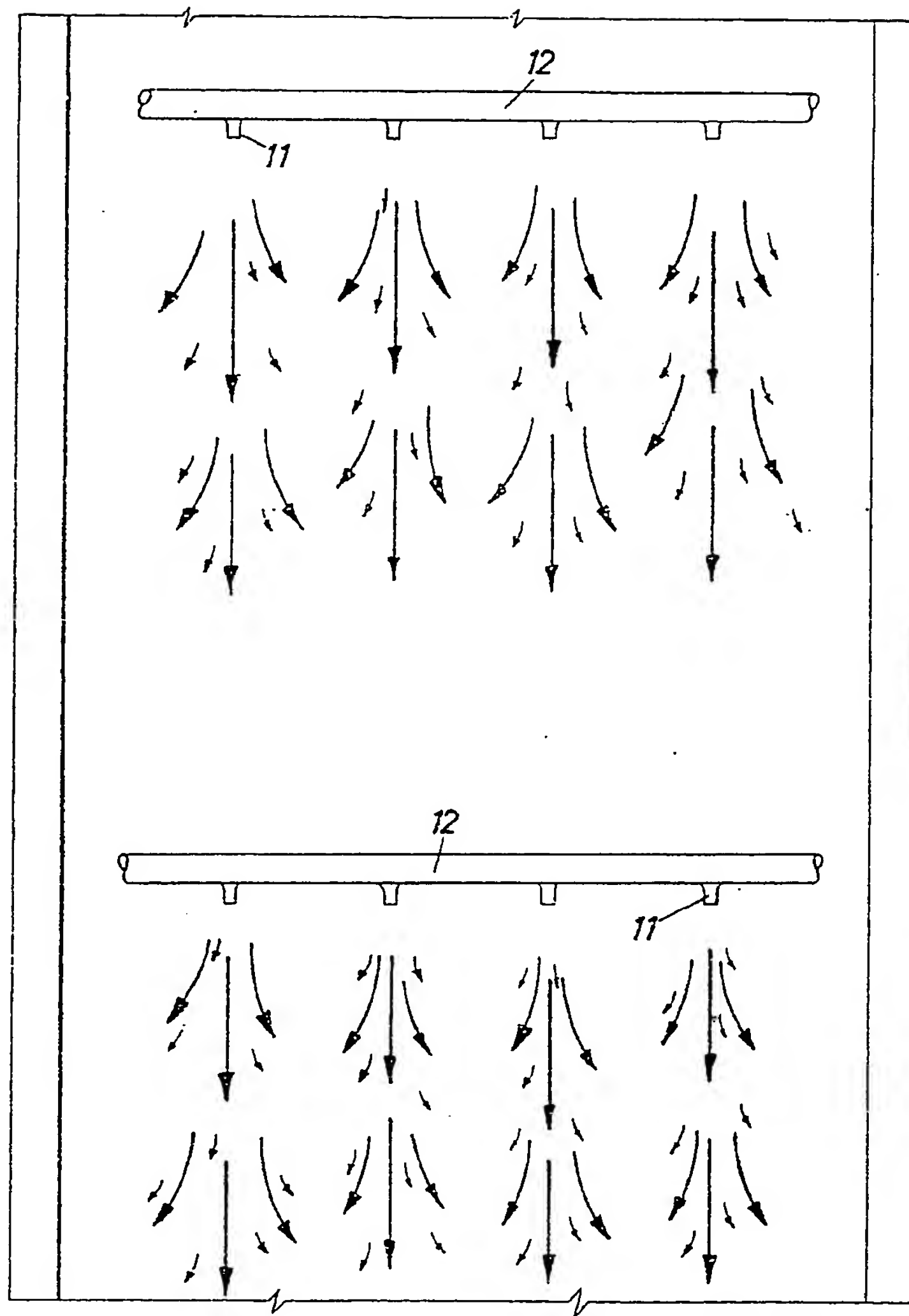


—FIG. 14.—









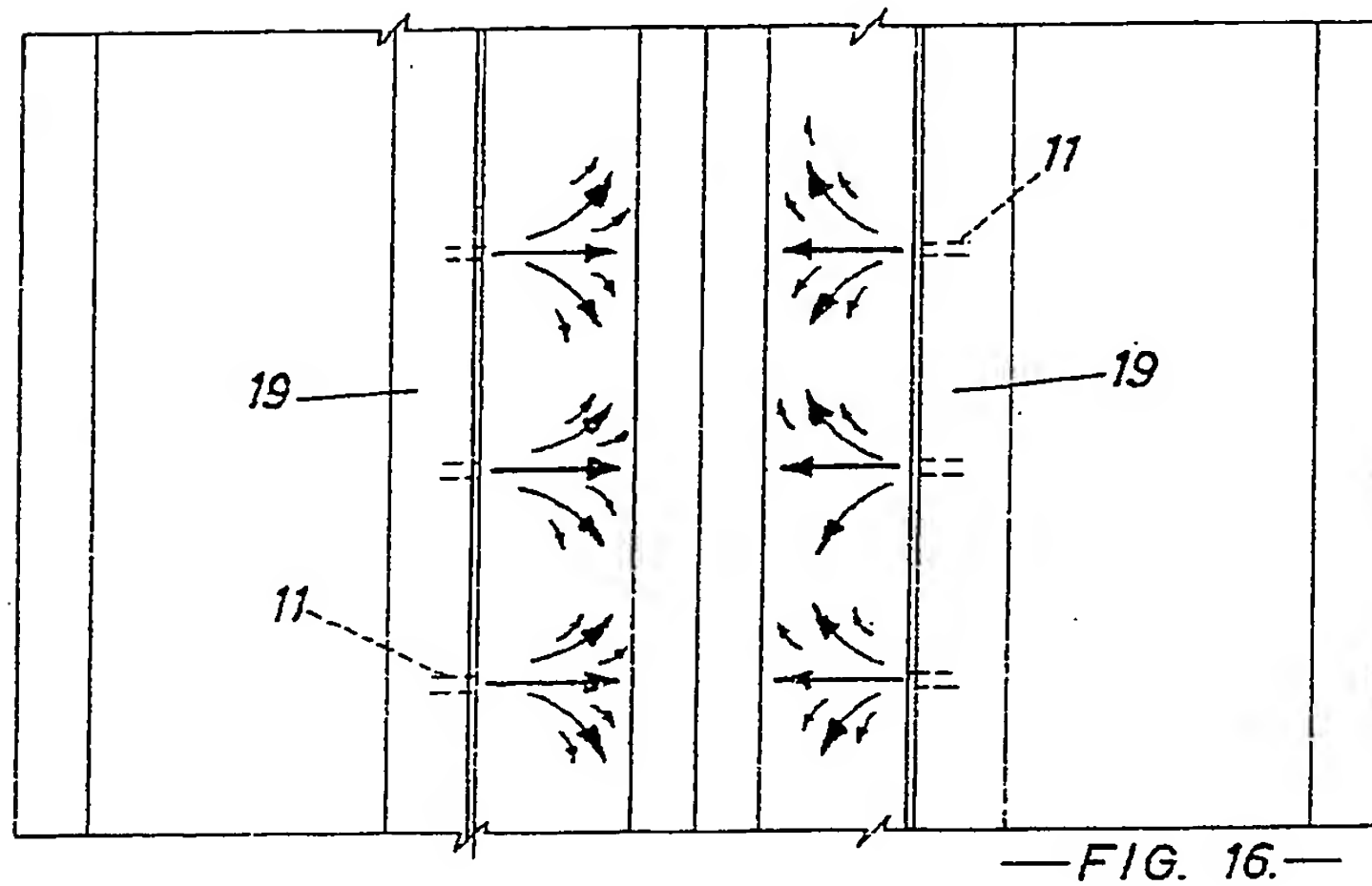
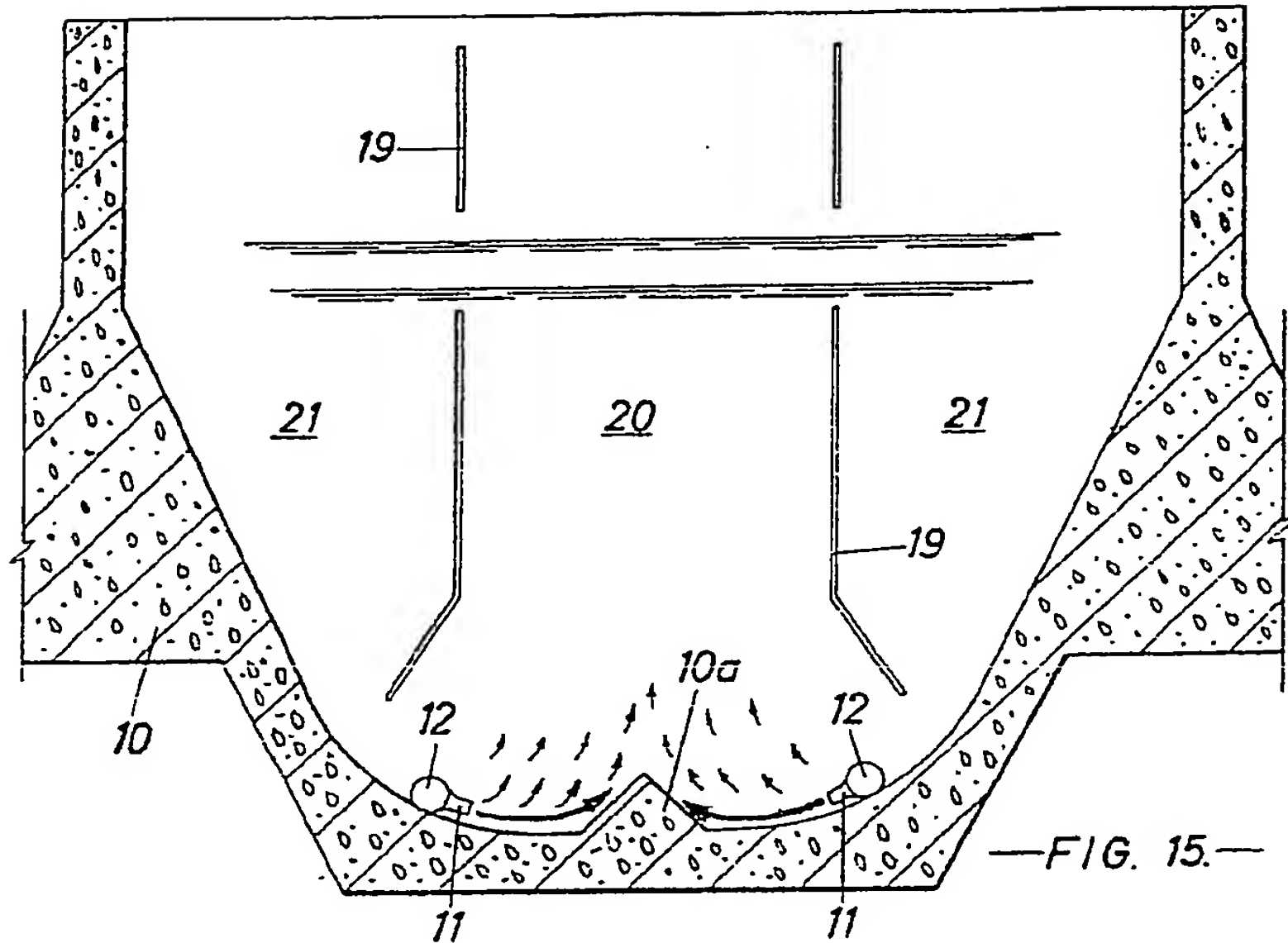
— FIG. 11. —

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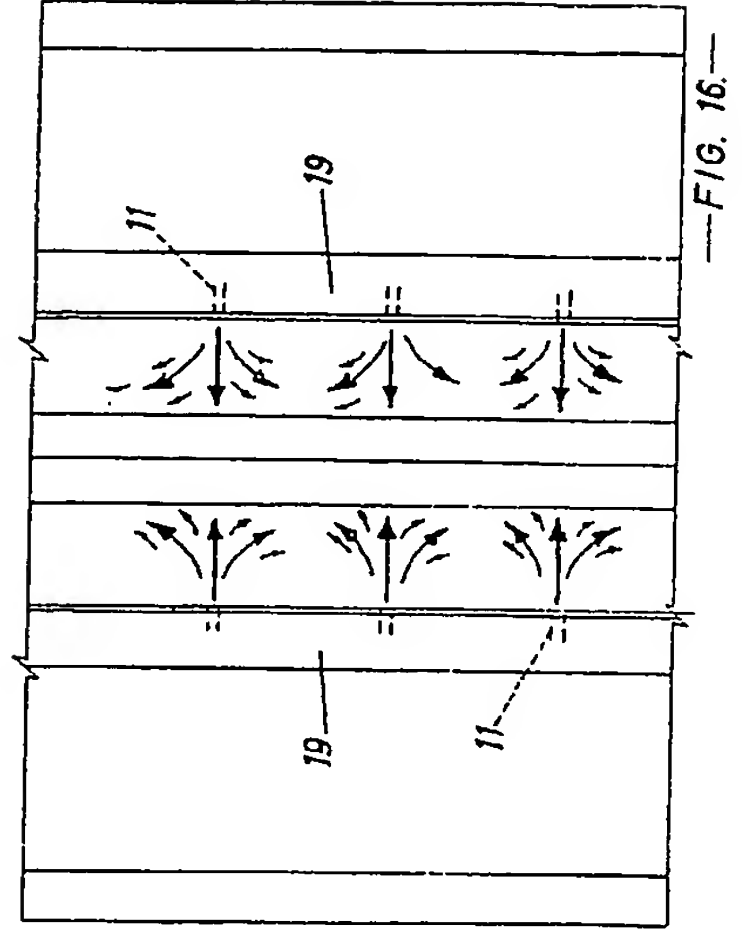
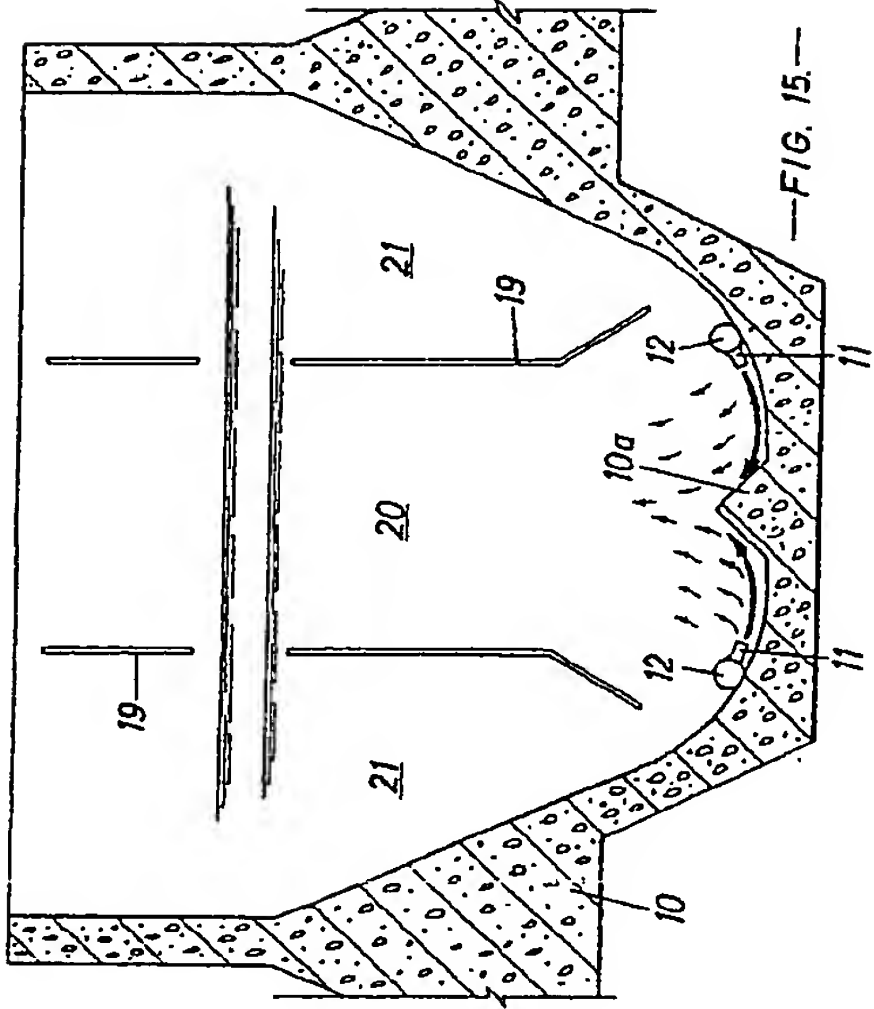
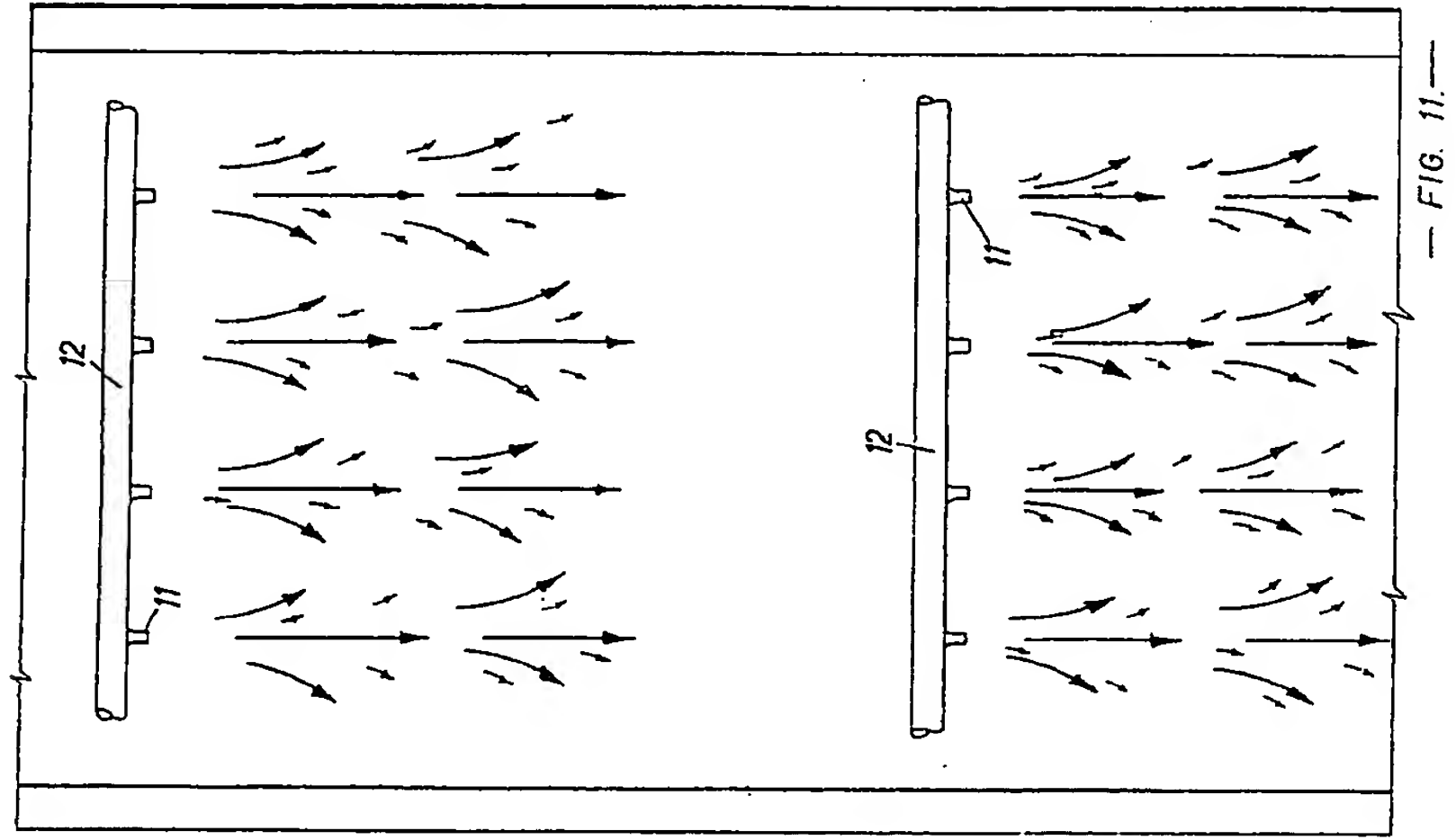
13 SHEETS

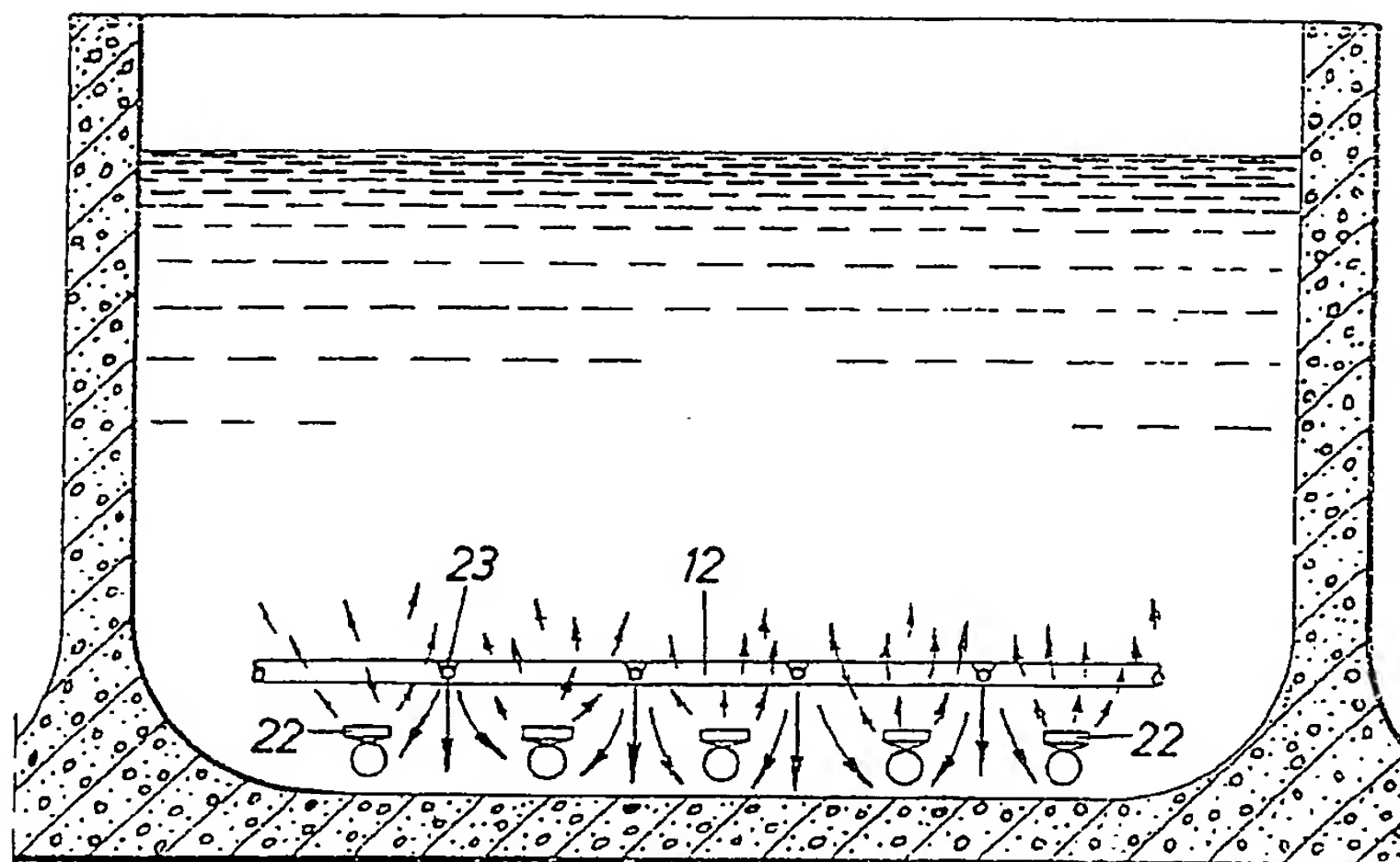
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the Original on a reduced scale.

SHEETS 6 & 7

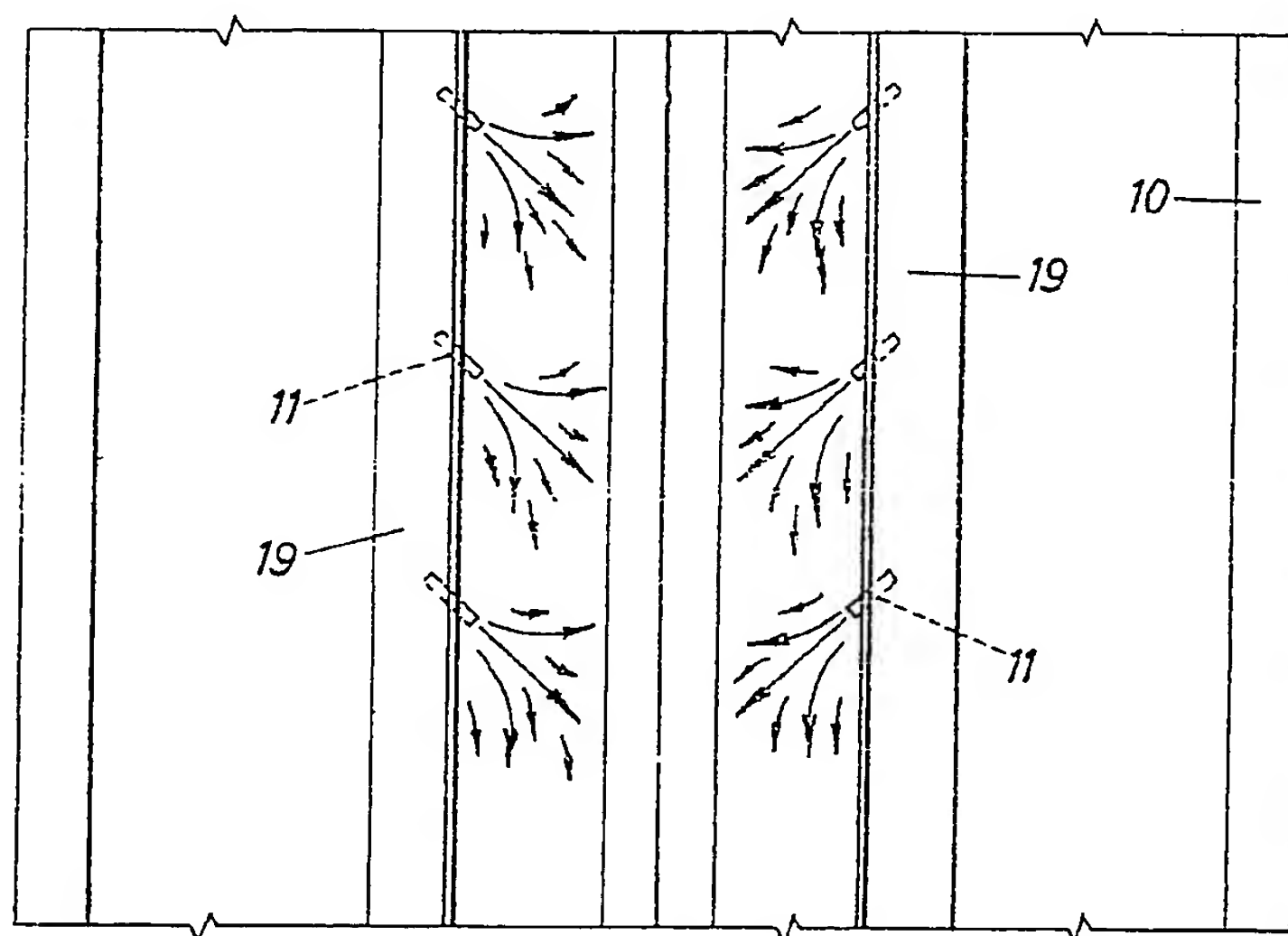


11.—





— FIG. 18. —

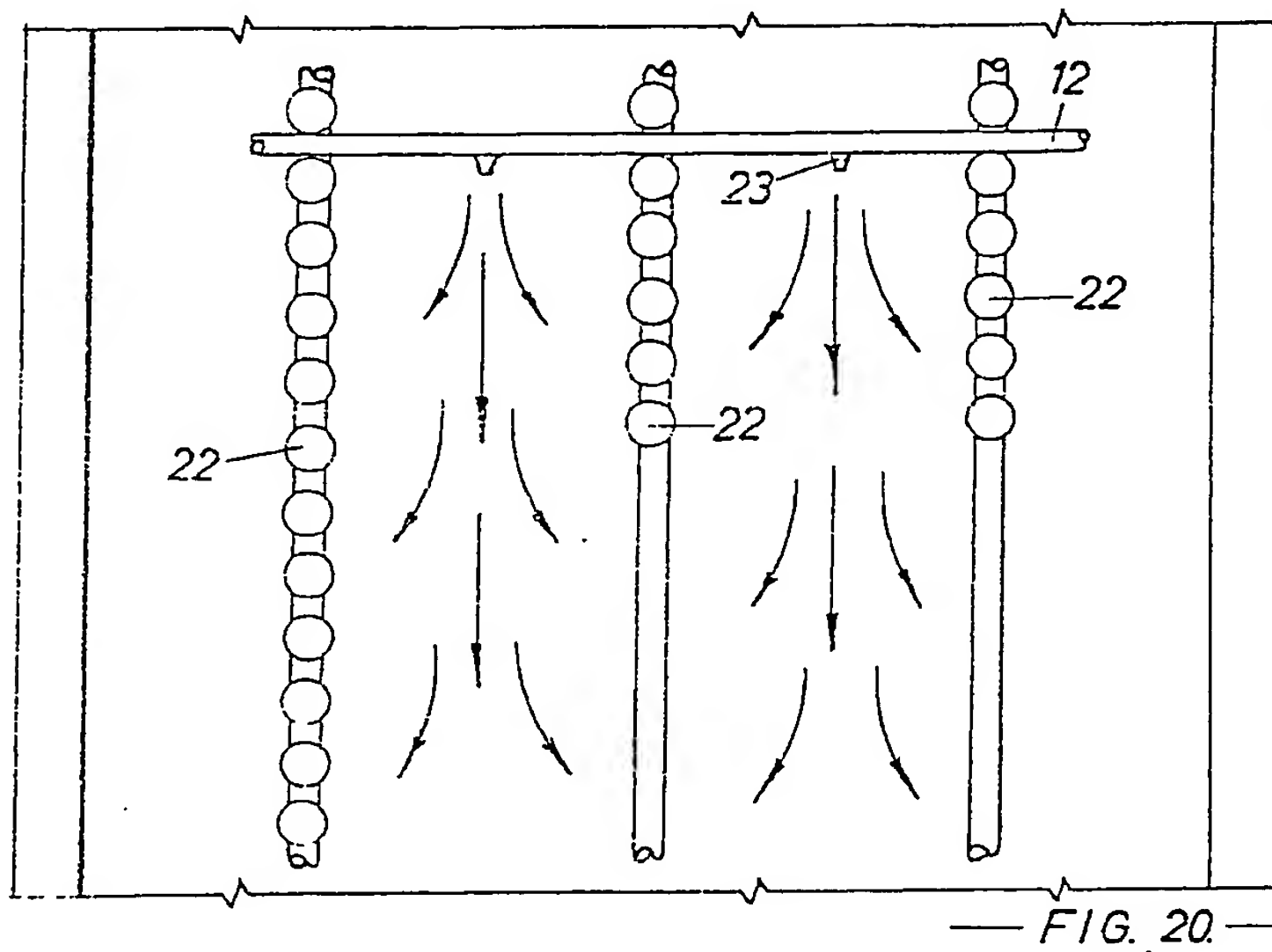
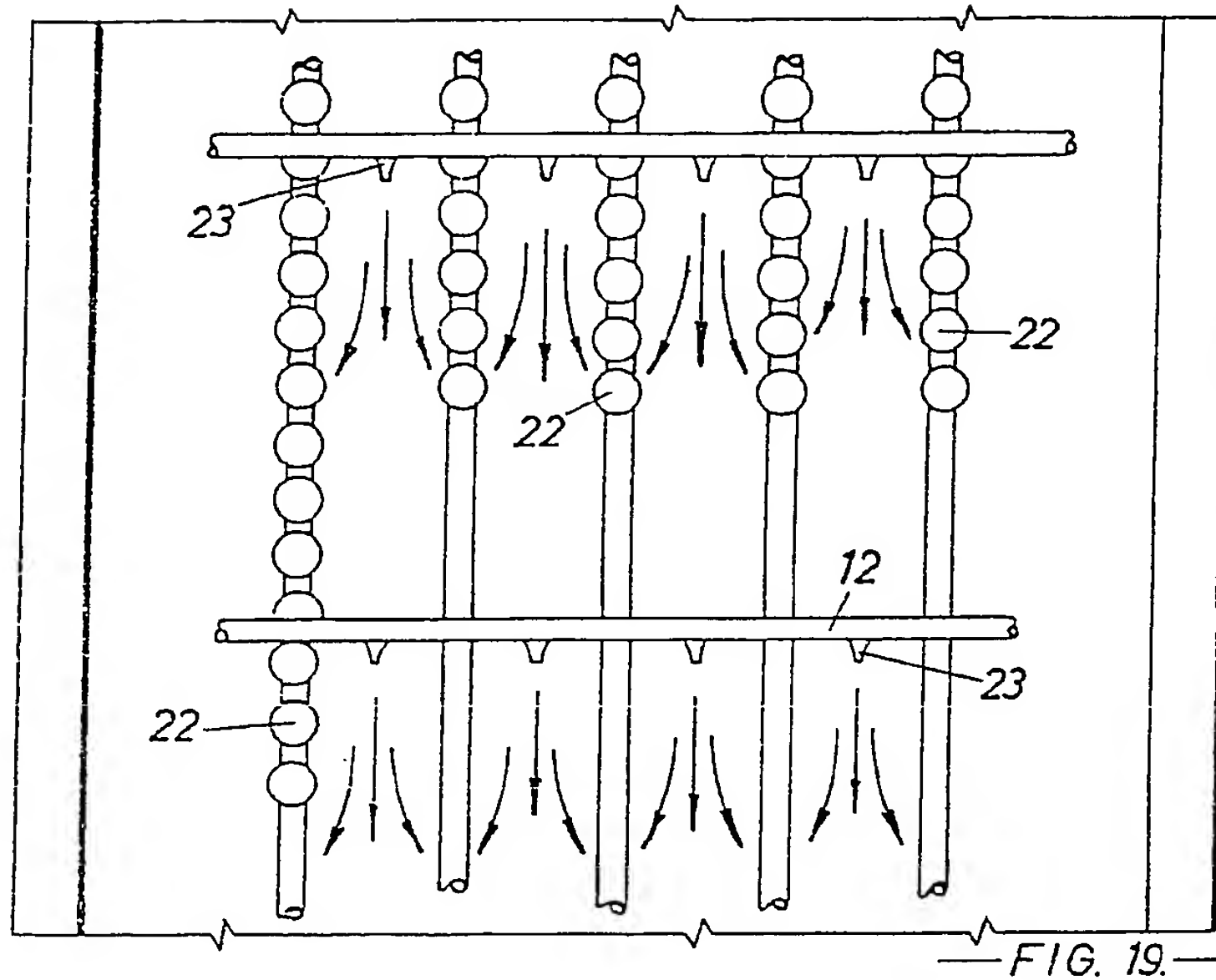
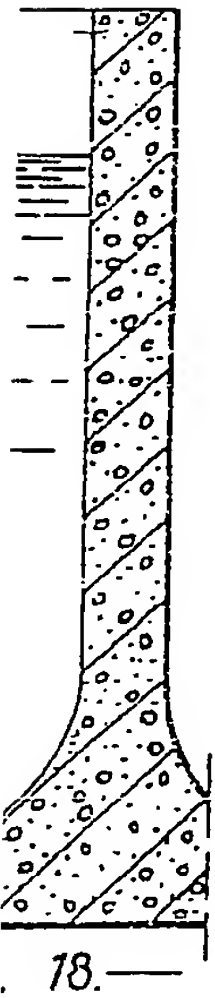


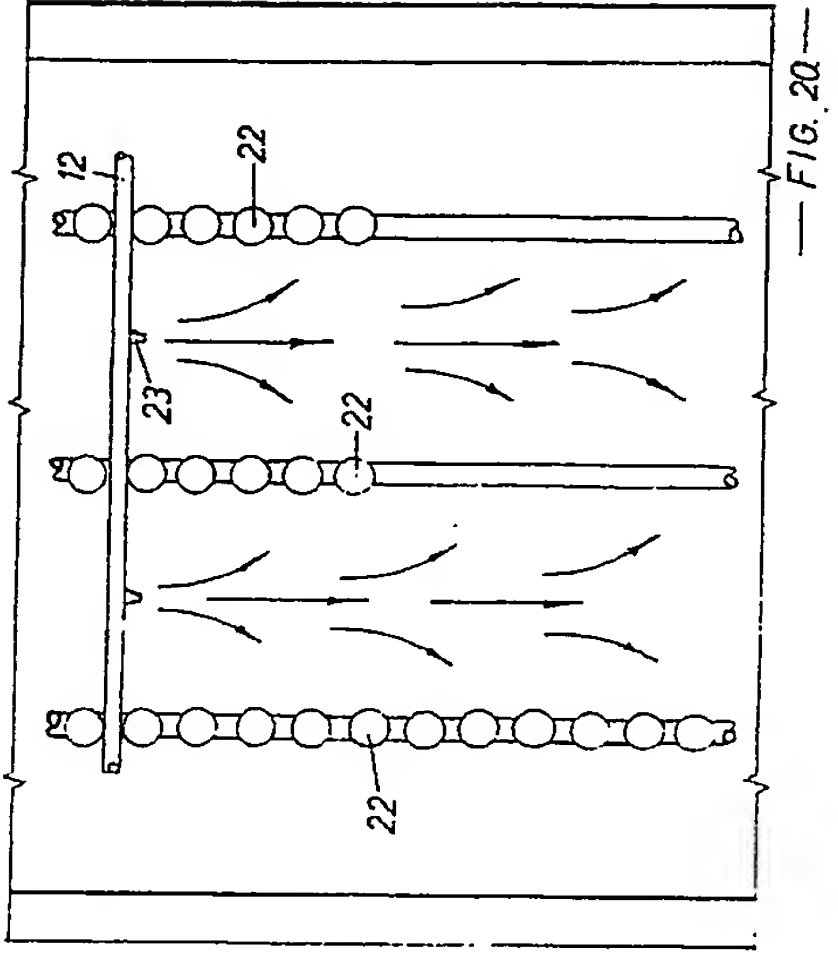
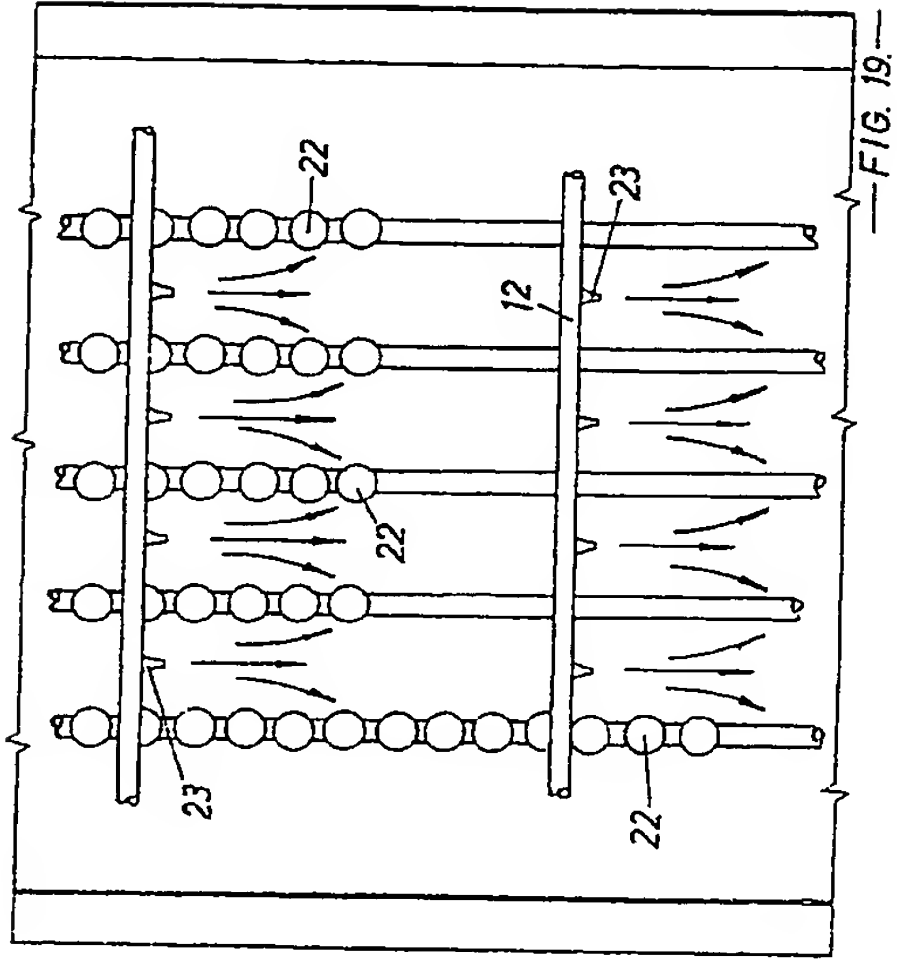
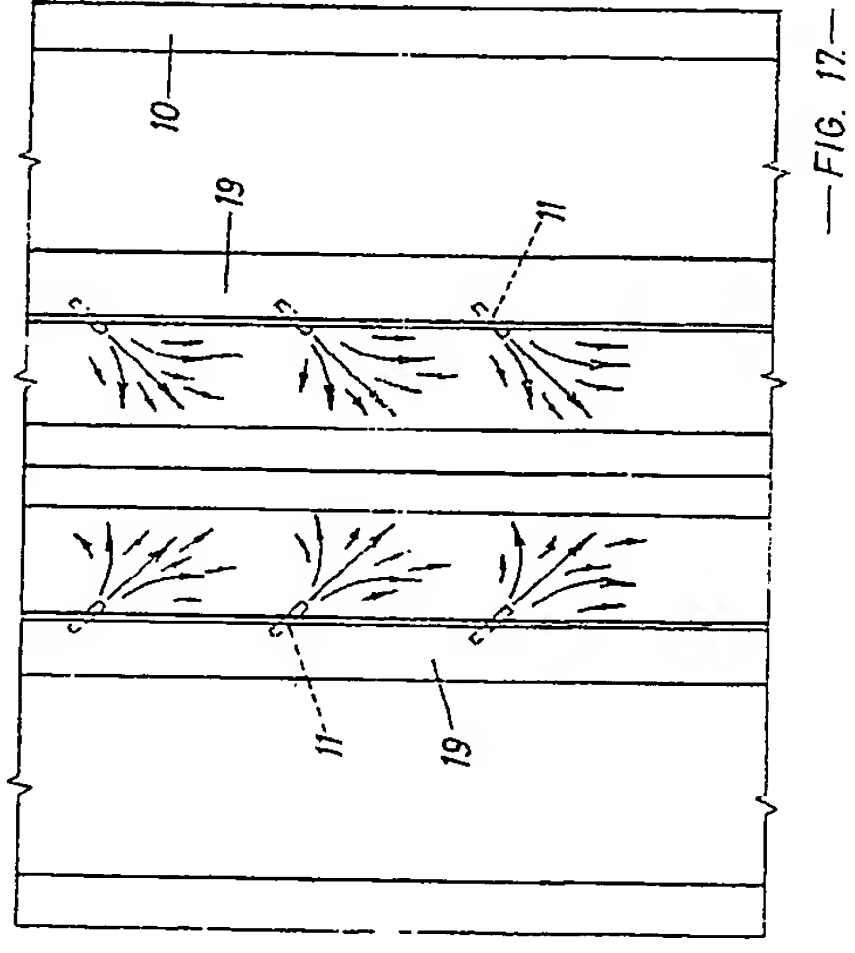
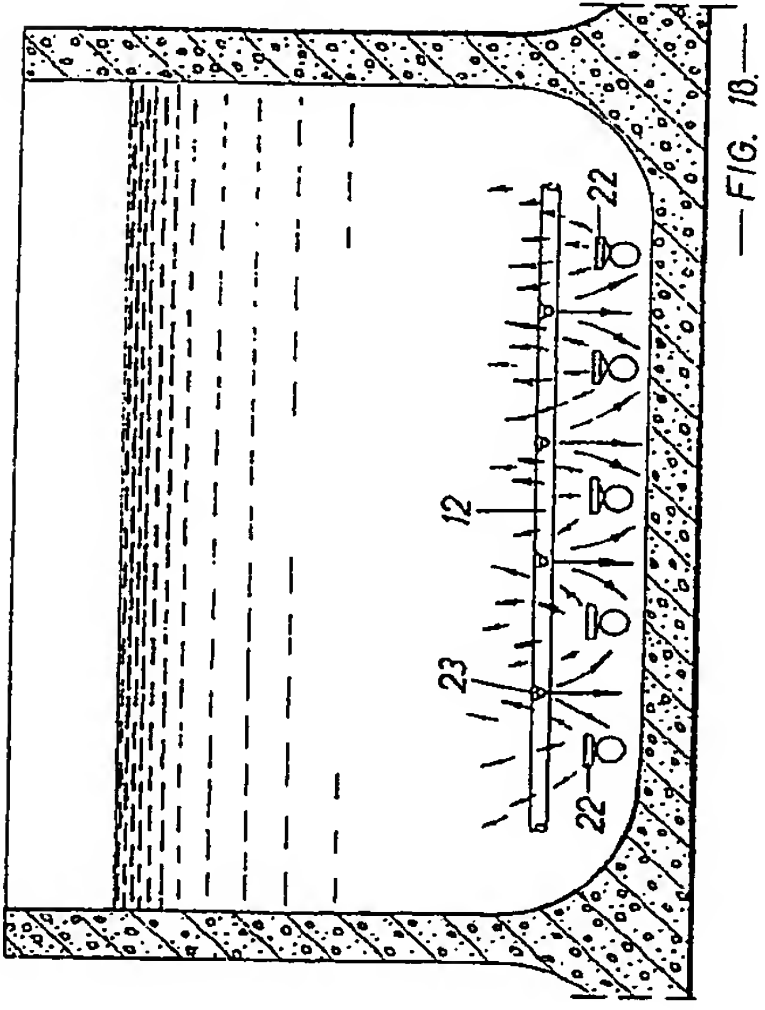
— FIG. 17. —

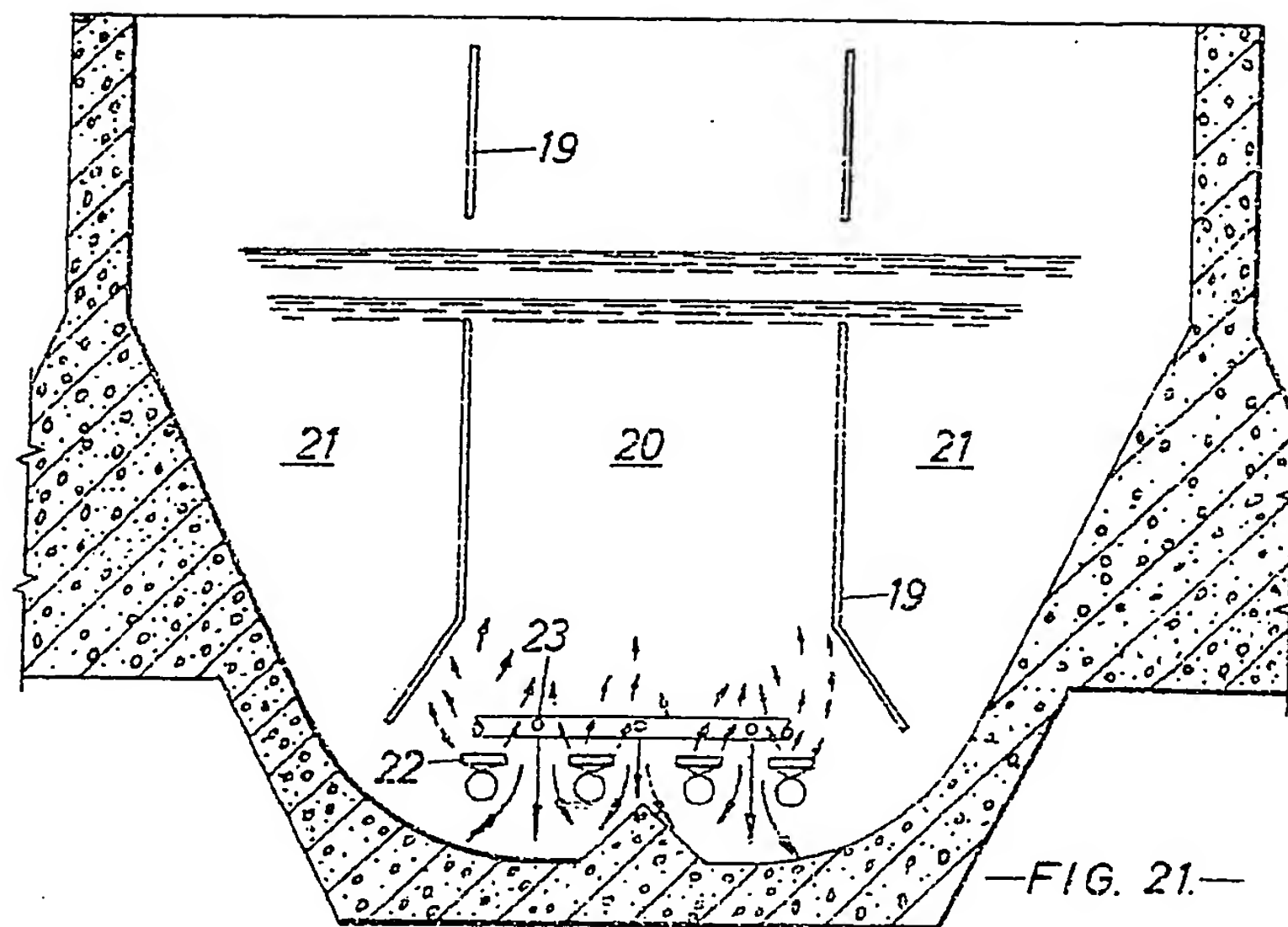


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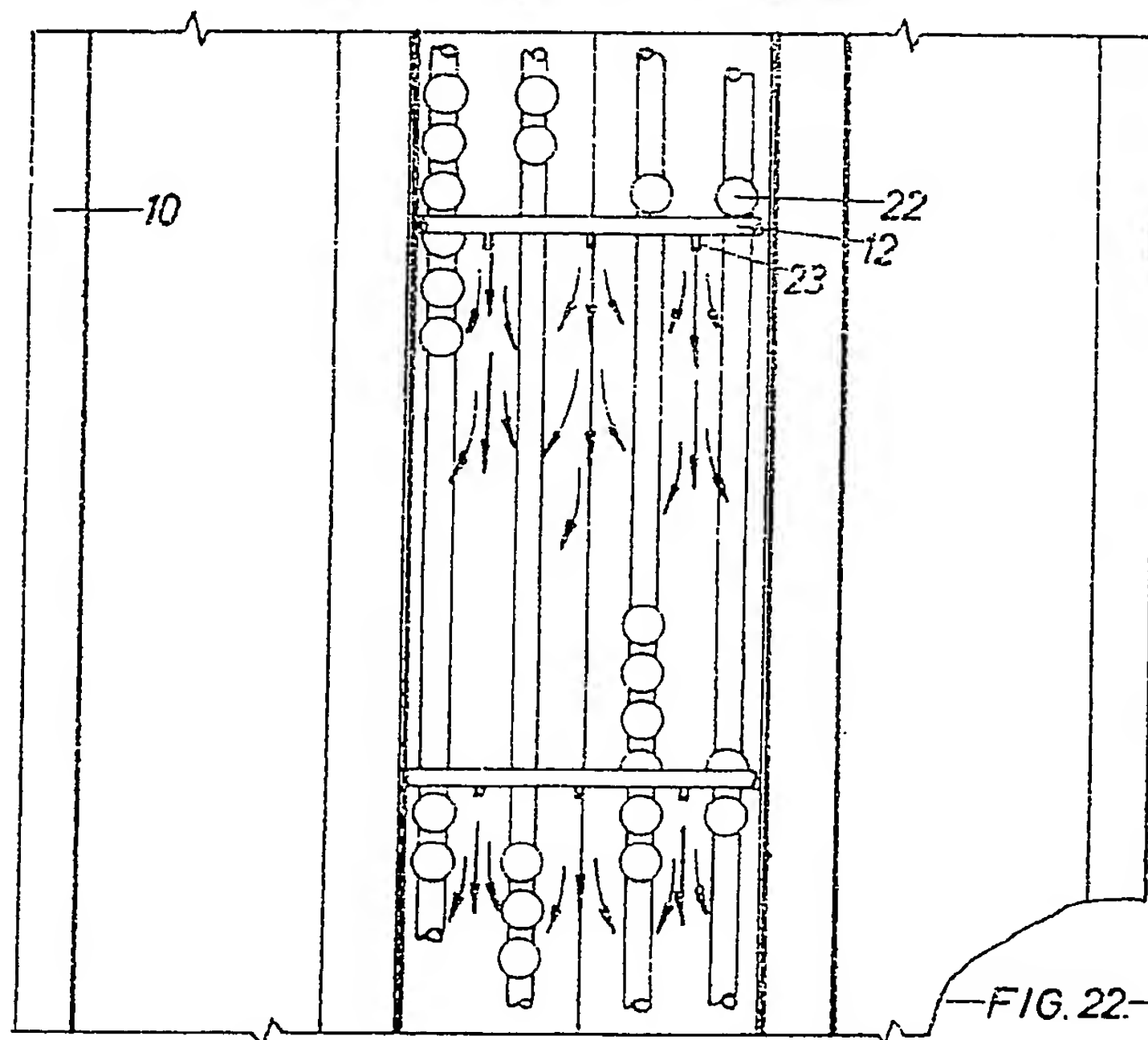
13 SHEETS This drawing is a reproduction of  
the Original on a reduced scale.  
SHEETS 8 & 9







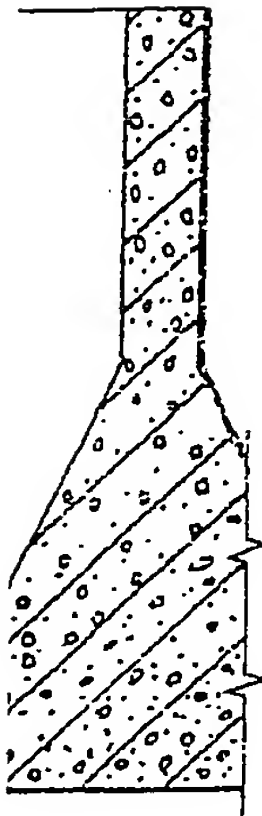
—FIG. 21.—



—FIG. 22.—

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the Original on a reduced scale.  
SHEETS 10 & 11



G. 21.—

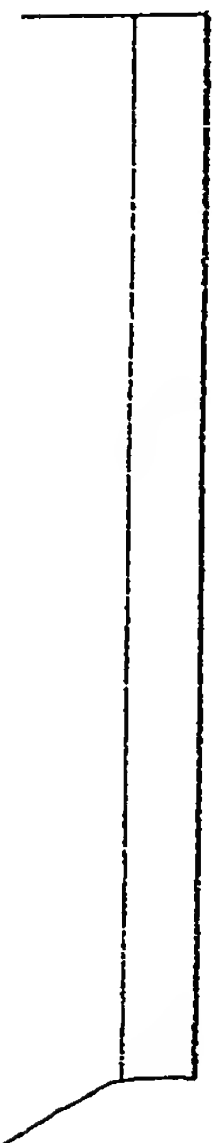
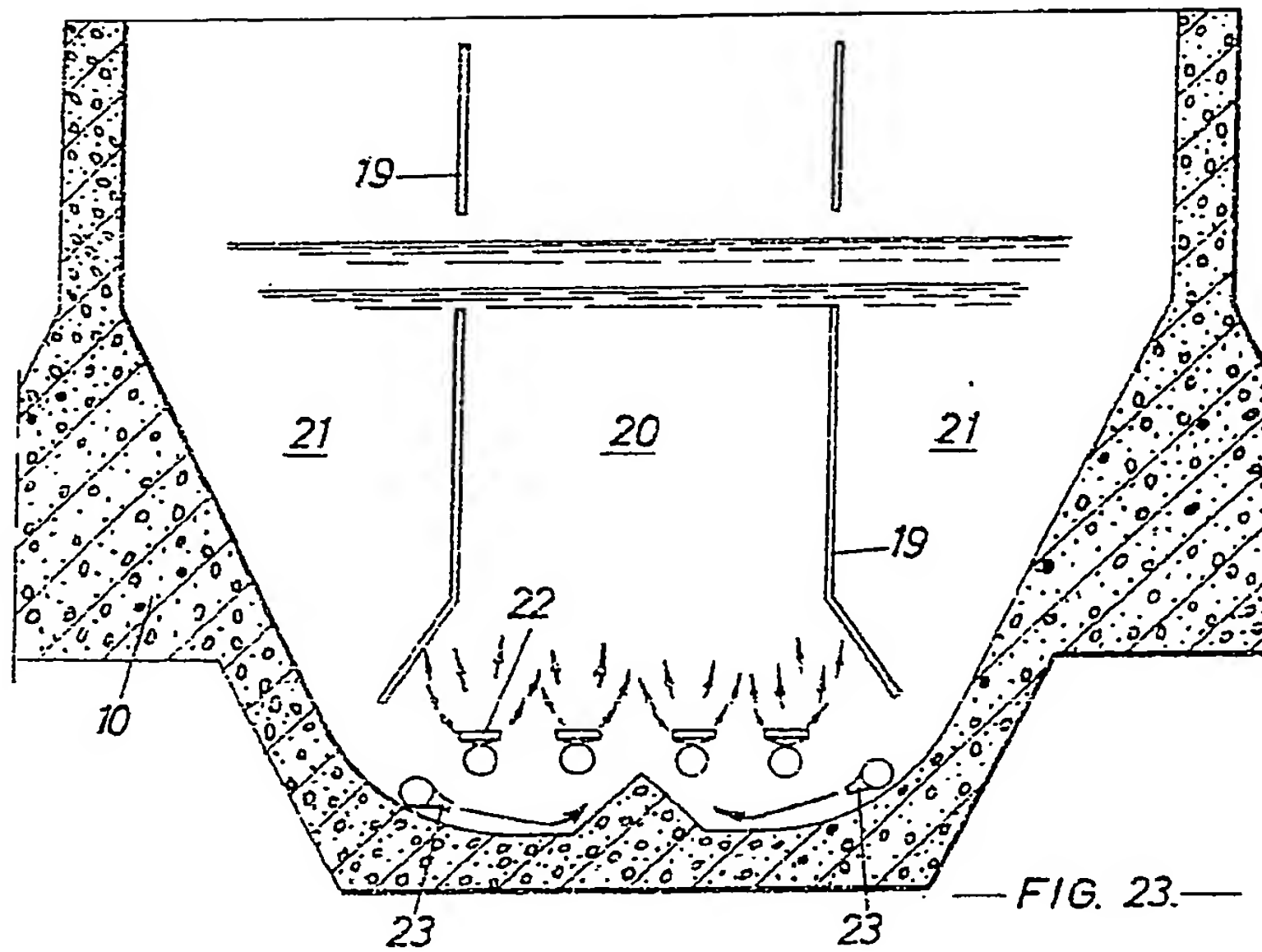
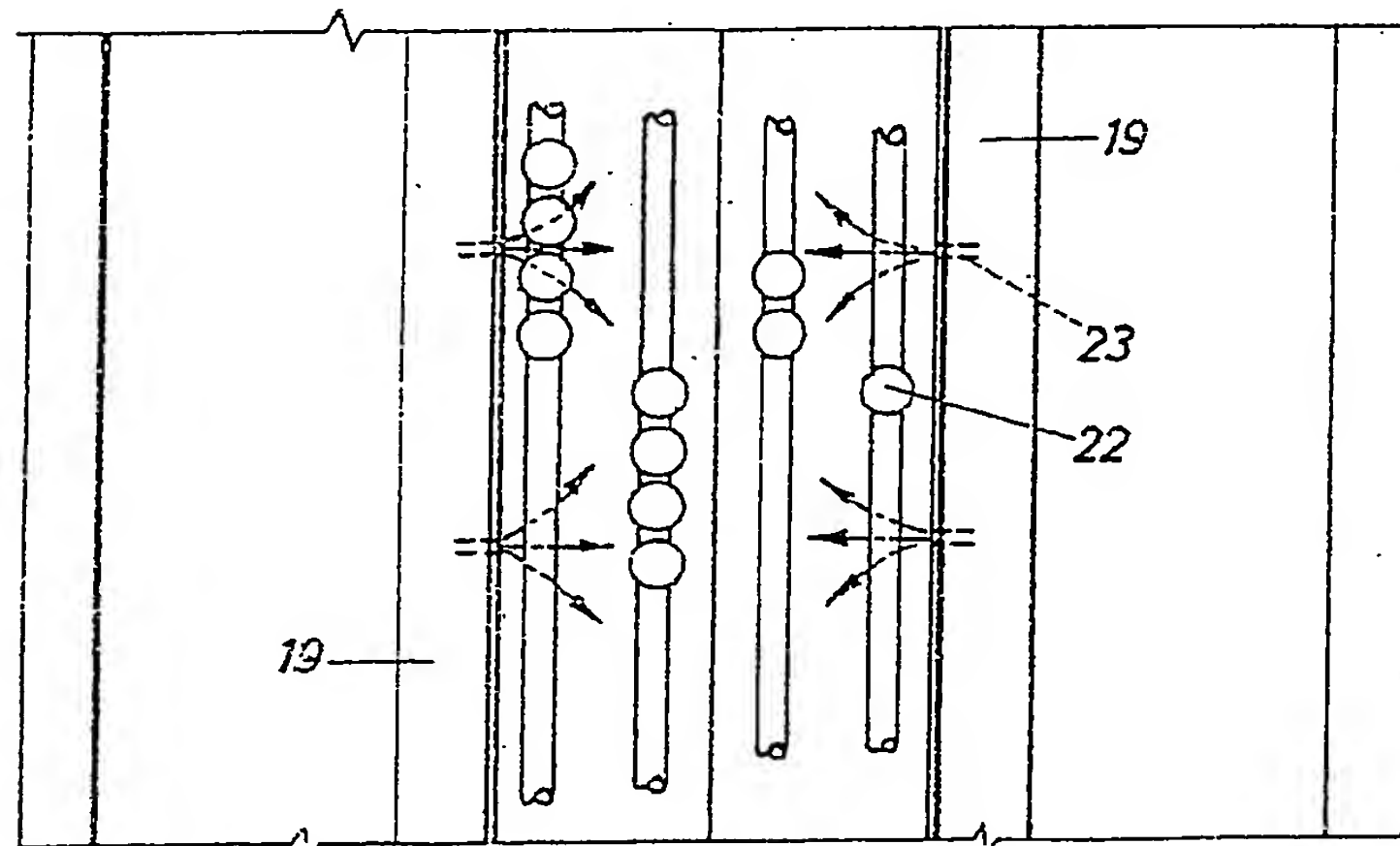


FIG. 22.—

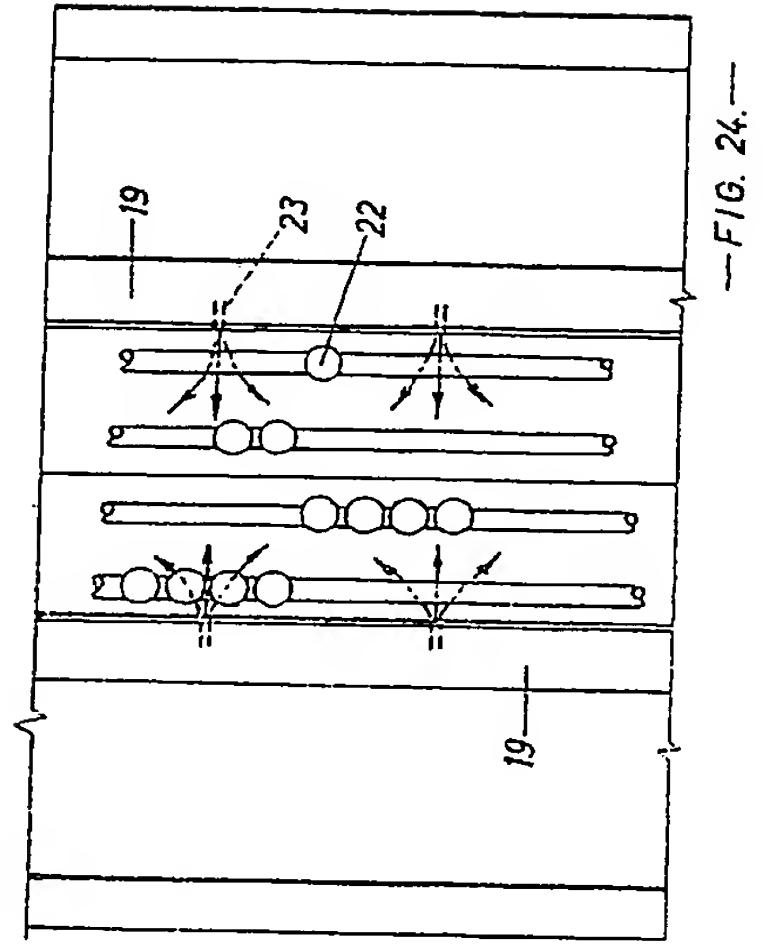
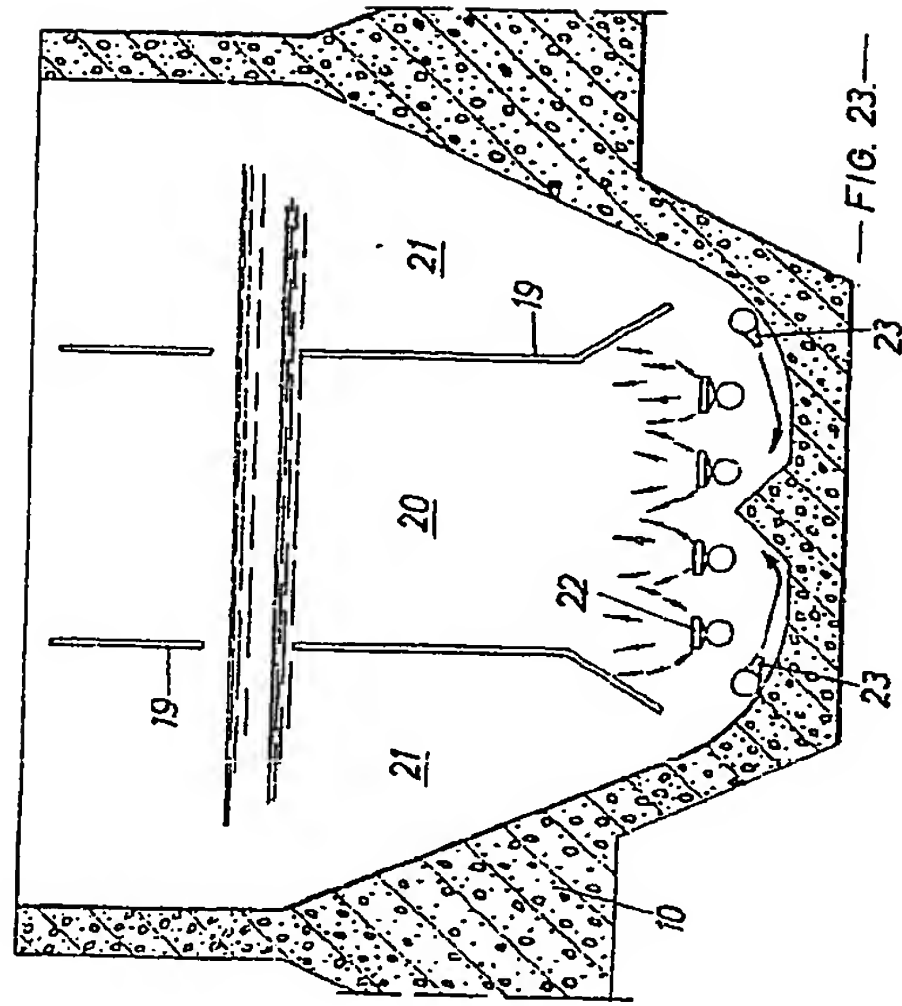
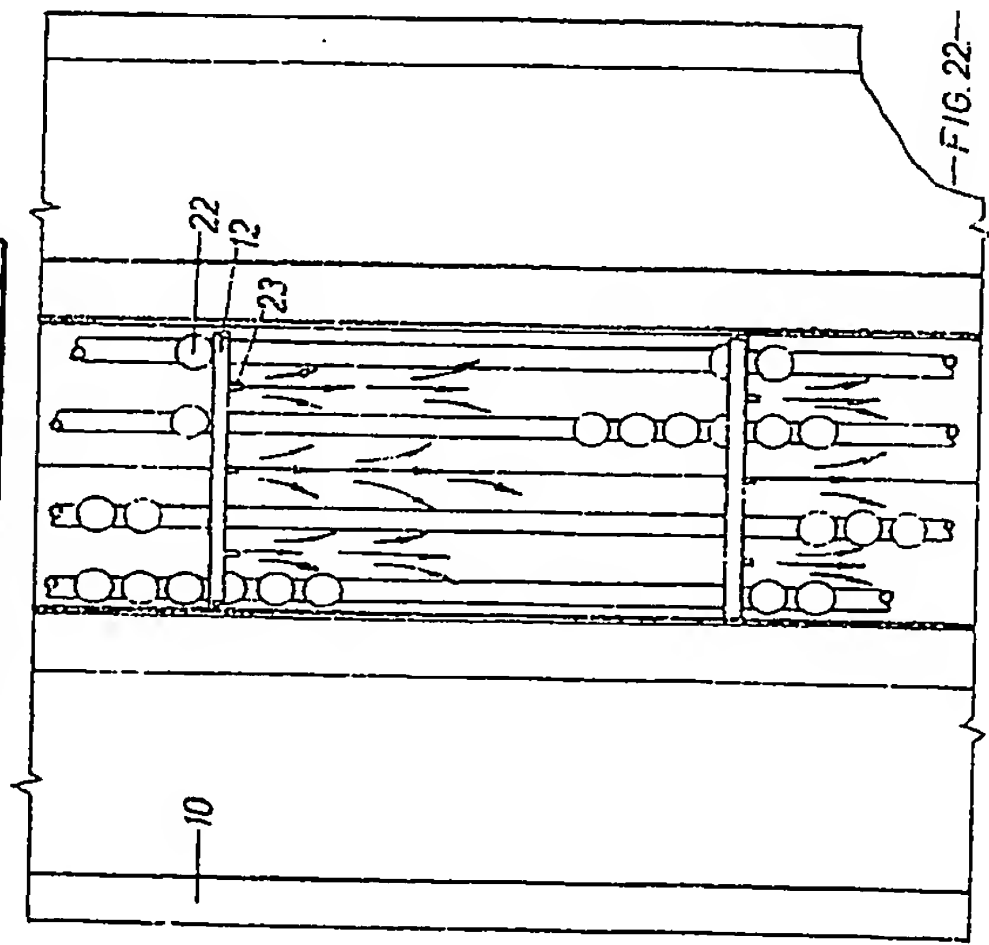
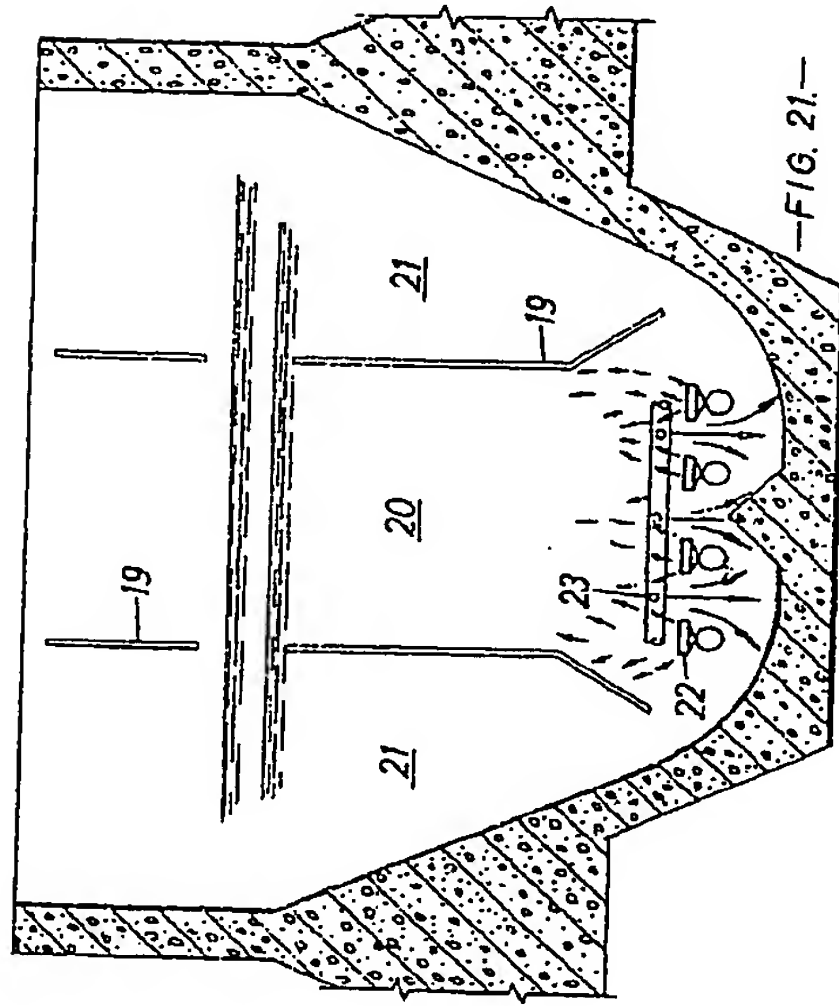


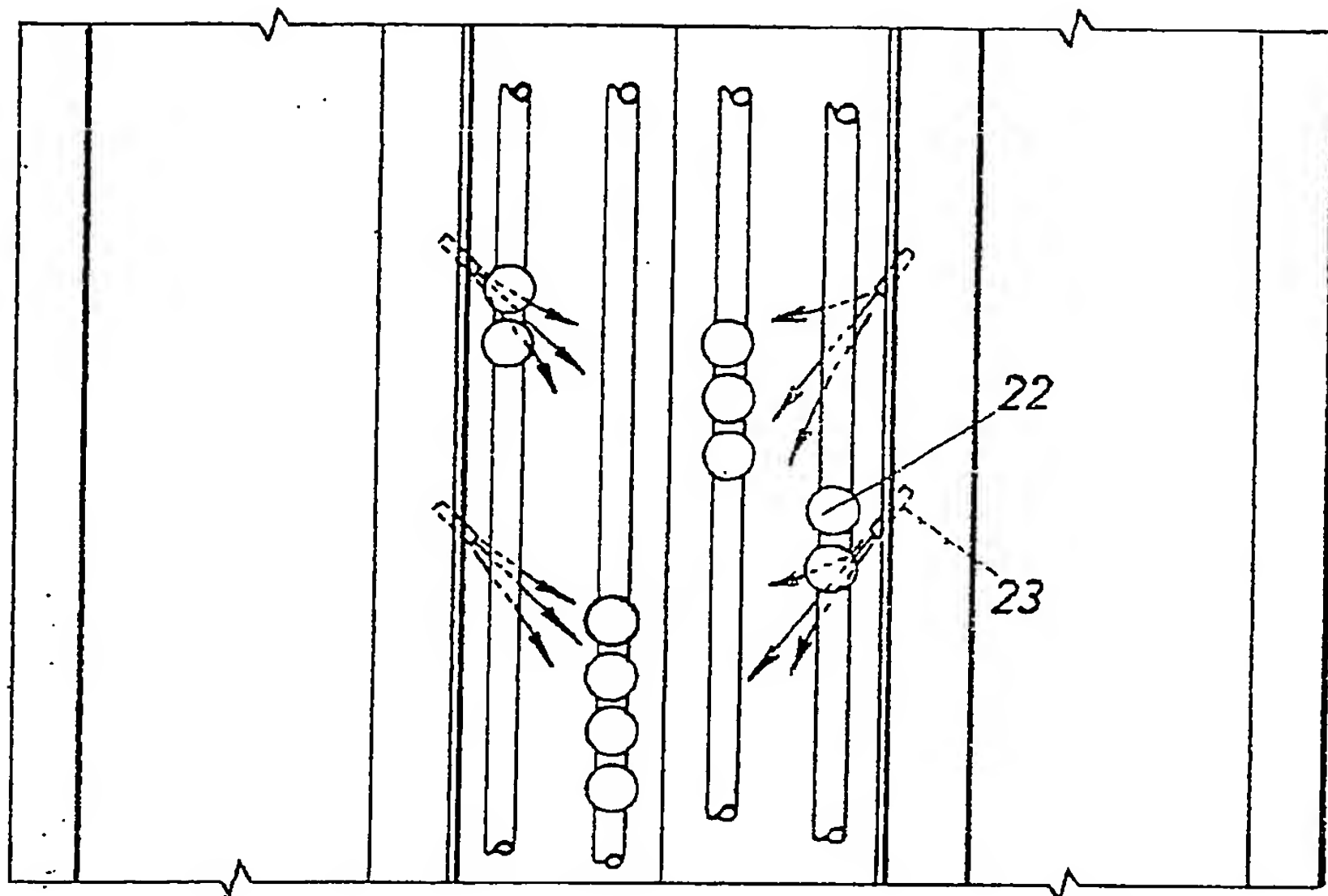
—FIG. 23.—



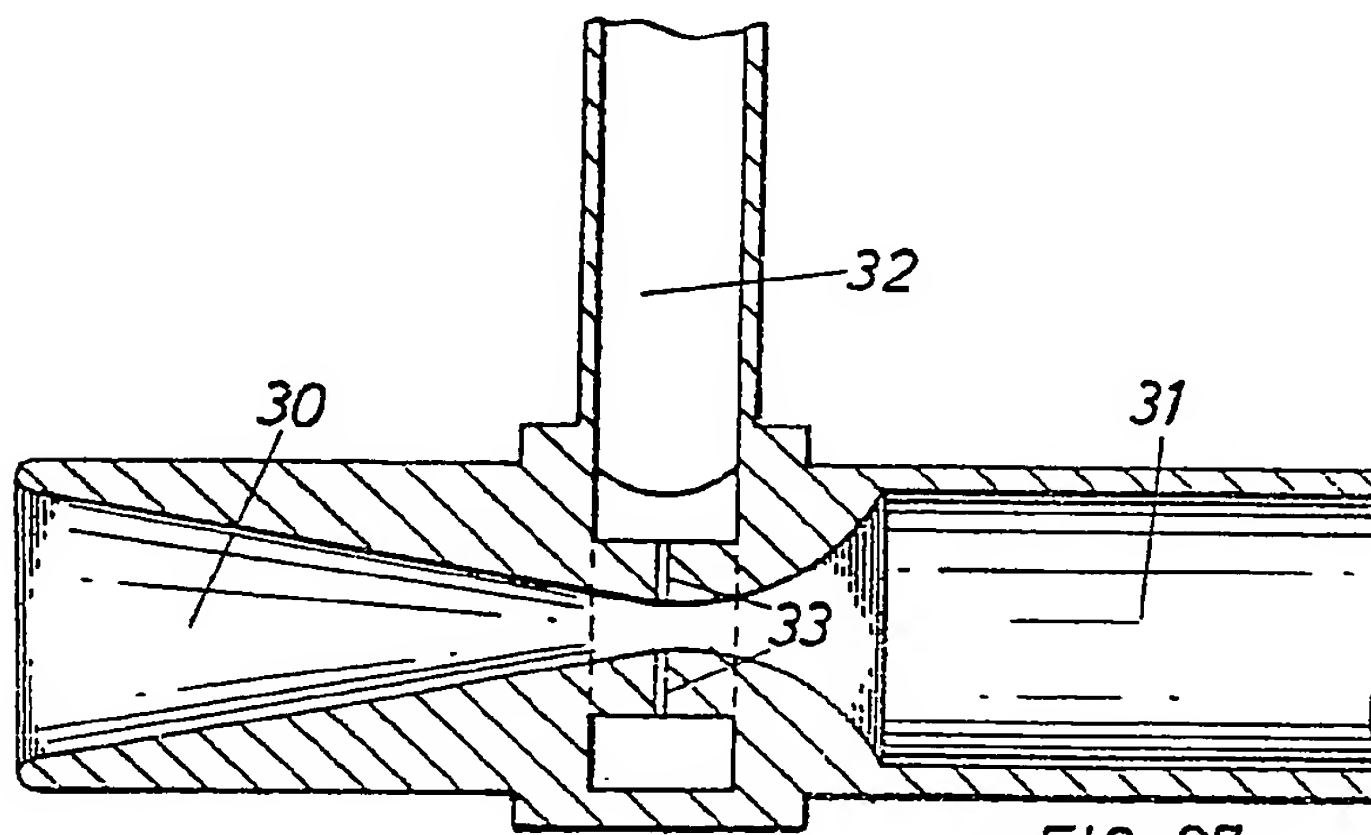
—FIG. 24.—



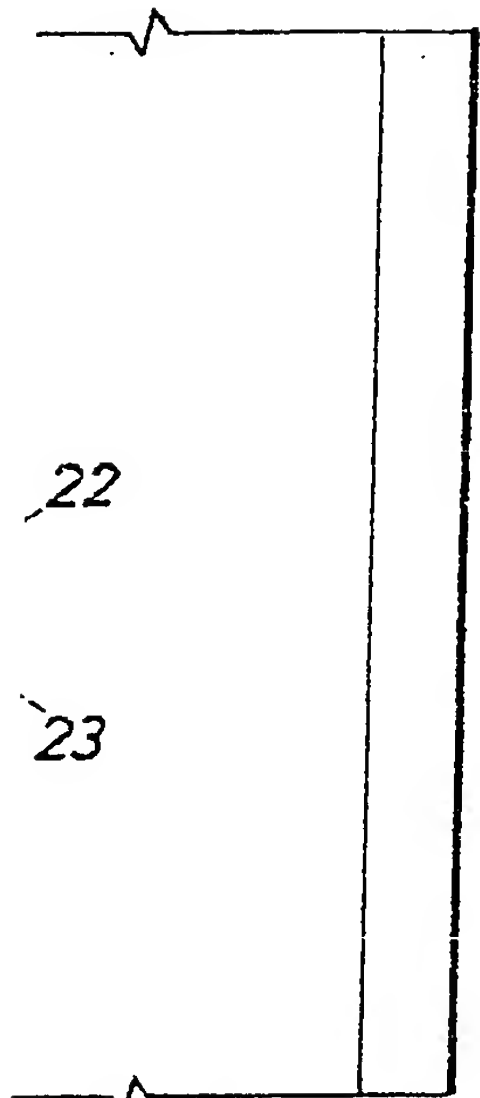




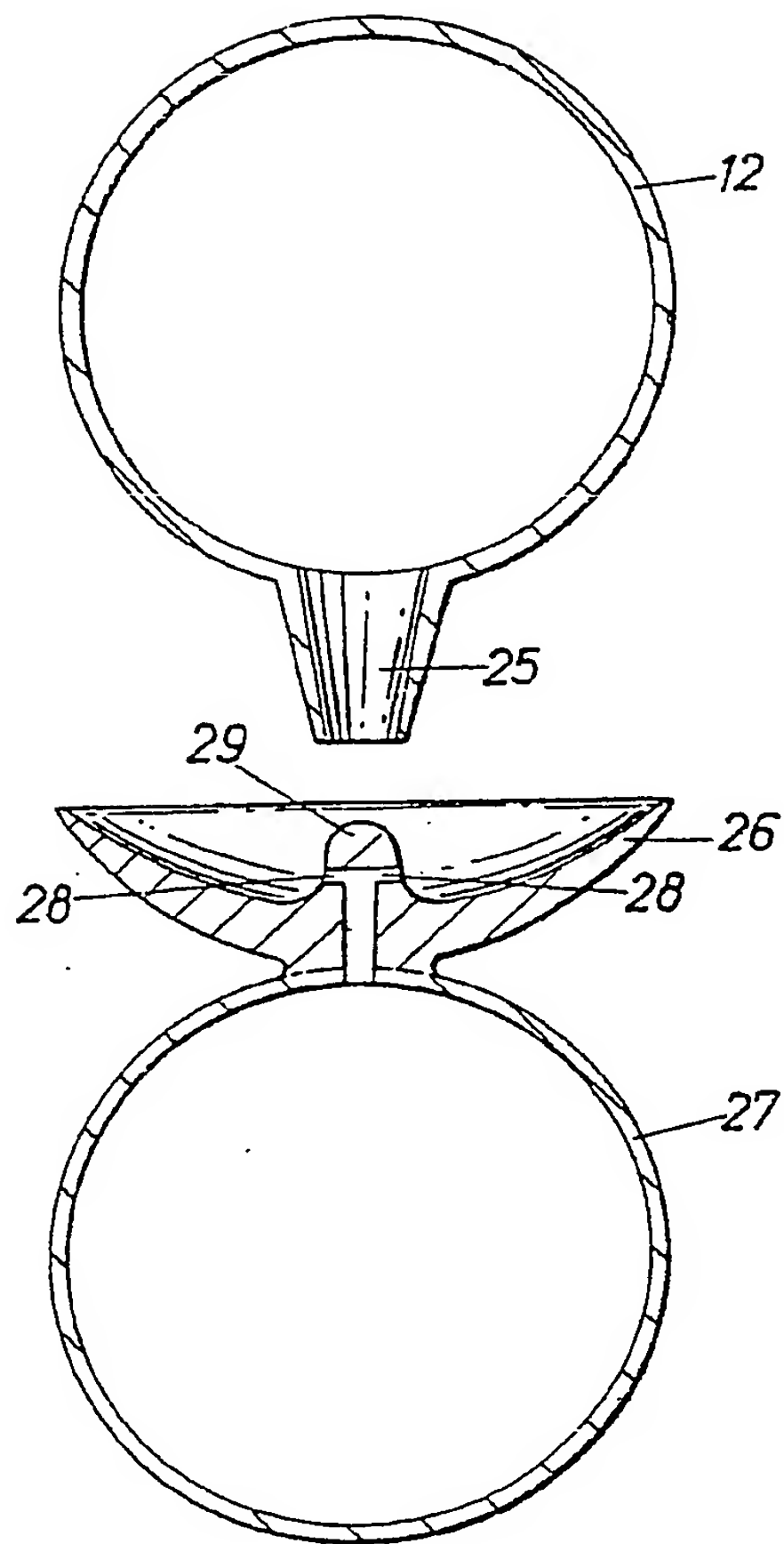
— FIG. 25. —



— FIG. 27. —



—FIG. 25.—



—FIG. 26.—

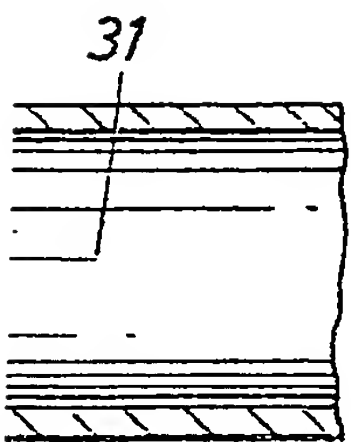
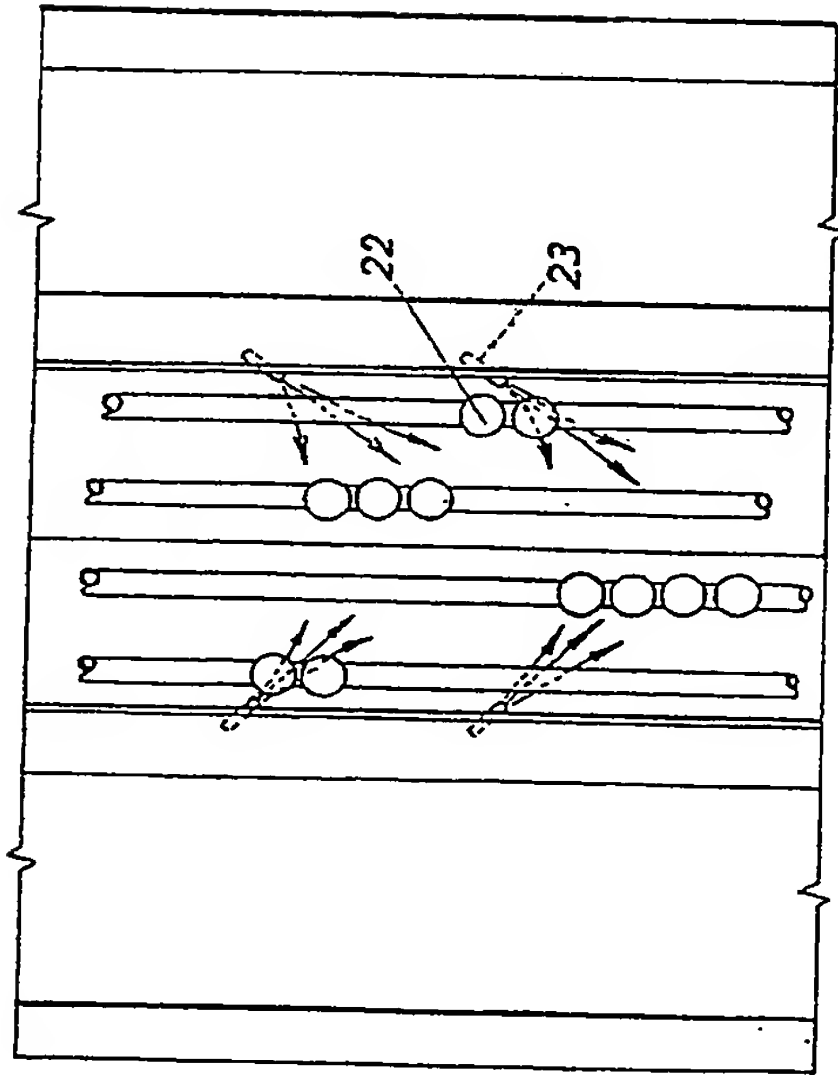
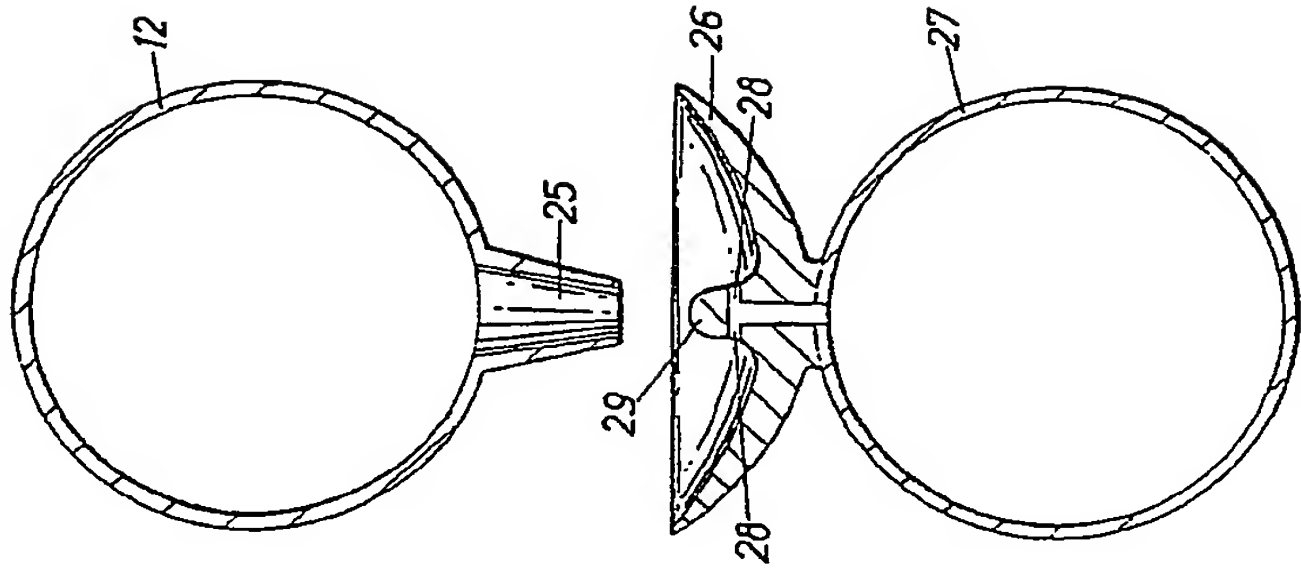


FIG. 27.—

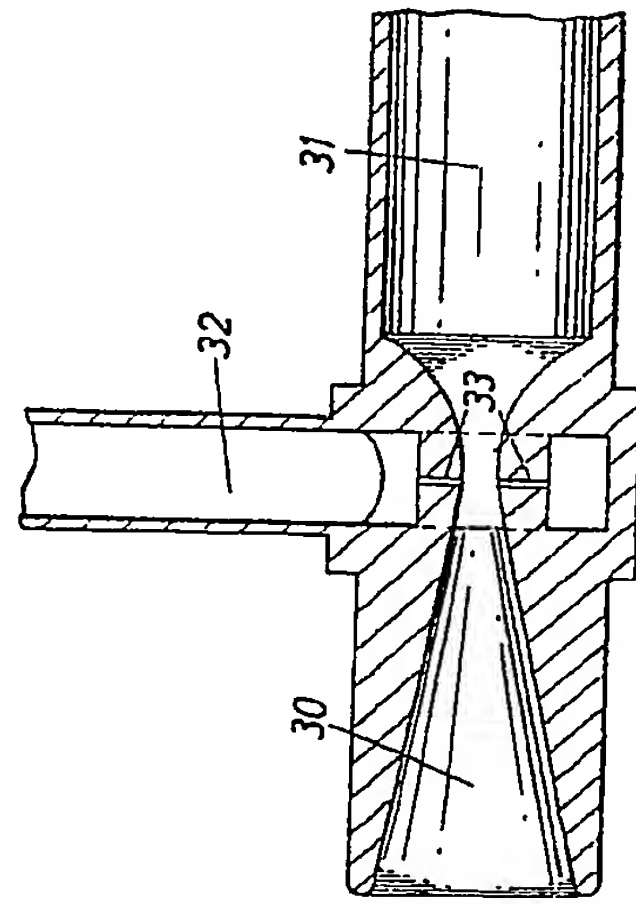
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— FIG. 25. —



— FIG. 26. —



— FIG. 27. —